PB-243 566

LITERATURE REVIEW AND BIBLIOGRAPHY OF MAMMALIAN TOXICOLOGY OF SELECT MUNITIONS

NATIONAL ENVIRONMENTAL RESEARCH CENTER

JUNE 1975

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

21600

EPA-670/9-75-008
June 1975

PB 243 566

LITERATURE REVIEW AND BIBLIOGRAPHY OF MAMMALIAN TOXICOLOGY OF SELECT MUNITIONS

By

Judith L. Mullaney

and

Robert G. Tardiff
Water Supply Research Laboratory

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

NATIONAL ENVIRONMENTAL RESEARCH CENTER
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-670/9-75-008	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE LITERATURE REVIEW AND BIBLIOGRAPHY OF MAMMALIAN TOXICOLOGY OF SELECT MUNITIONS		5. REPORT DATE June 1975; Issuing Date 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Judith L. Mullaney and Robert G. Tardiff		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Water Supply Res. Lab., NERC, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268 and U.S. Army Biomedical R & D Command Washington, D.C.		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS National Environmental Research Center Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268		13. TYPE OF REPORT AND PERIOD COVERED Final 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

The scientific literature for the past 100 years was researched to obtain a comprehensive review of the biological effects of ten military munitions. The procedure and resulting bibliography were compiled for an evaluation of the reported toxicity and health hazards of these compounds at environmental levels. This bibliography is an expurgated form of the final report performed under a contract with the U.S. Army. Therefore, it should be emphasized that some cited references apply to excluded material since the arrangement of sectional bibliographies was retained intact. Arrangement of the information was alphabetical by compound name preceded by a general approach to the literature. Substantial published material was retrieved for three of the compounds, pentaerythritol tetranitrate, titanium, and potassium perchlorate. Assuming the toxicity of lead styphnate to be referable to the lead ion, a significant amount of data on the human health hazards of lead styphnate was located. Retrieval for dinitrotoluene, hexachloroethane, nitroguanidine, and potassium chlorate was categorized as primarily supportive toxicity data. Red phosphorus and tetrazene research indicated a paucity of data, very noticeable in their bibliographies. There are 428 references in the bibliography, 292 specific to compound material, 136 general munitions references.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Bibliographies Search structuring Index terms Explosives Toxicology Pyrotechnics Perchlorates Titanium	DNT Hexachloroethane Lead styphnate Nitroguanidine PETN Potassium chlorate Red phosphorus Tetrazene	6T 13B

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report)	21. NO. OF PAGES
RELEASE TO PUBLIC	Unclassified	73
	20. SECURITY CLASS (This page) Unclassified	22. PRICE 4.25/2.25

EPA Form 2220-1 (9-73)

REVIEW NOTICE

This report has been reviewed by the National Environmental Research Center, Cincinnati, and approved for publication. The work was performed under contract with U.S. Army Medical Research and Development Command, Washington, D.C., Colonel LeRoy H. Reuter, Ph.D., project officer. Mention of trade names or commercial products does not necessarily constitute endorsement or recommendation for use.

FOREWORD

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise, and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment--air, water, and land. The National Environment Research Centers provide this multidisciplinary focus through programs engaged in

- studies on the effects of environmental contaminants on man and the biosphere, and
- a search for ways to prevent contamination and to recycle valuable resources.

This report represents the bibliographic strategy and literature research conducted for the toxicological assessment of select munitions compounds in preparation for the establishment of effluent guidelines and discharge criteria.

A. W. Breidenbach, Ph. D.
Director
National Environmental
Research Center, Cincinnati

ABSTRACT

The scientific literature for the past 100 years was researched to obtain a comprehensive review of the biological effects of ten military munitions. The procedure and resulting bibliography were compiled for an evaluation of the reported toxicity and health hazards of these compounds at environmental levels. This bibliography is an expurgated form of the final report performed under a contract with the U. S. Army. Therefore, it should be emphasized that some cited references apply to excluded material since the arrangement of sectional bibliographies was retained intact. Arrangement of the information was alphabetical by compound name preceded by a general approach to the literature. Substantial published material was retrieved for three of the compounds, pentaerythritol tetranitrate, titanium, and potassium perchlorate. Assuming the toxicity of lead styphnate to be referable to the lead ion, a significant amount of data on the human health hazards of lead styphnate was located. Retrieval for dinitrotoluene, hexachloroethane, nitroguanidine, and potassium chlorate was categorized as primarily supportive toxicity data. Red phosphorus and tetrazene research indicated a paucity of data, very noticeable in their bibliographies. There are 428 references in the total bibliography, 292 specific to compound material, 136 general munitions references.

TABLE OF CONTENTS

	Page
Foreword	iii
Abstract	iv
Introduction	1
Dinitrotoluene	6
Hexachloroethane	13
Lead Styphnate	17
Nitroguanidine	20
Pentaerythritol Tetranitrate	23
Potassium Chlorate	29
Potassium Perchlorate	33
Red Phosphorus	37
Tetrazene	46
Titanium	49
General References	54

INTRODUCTION

Background. Munitions comprise military-unique compounds whose manufacture, milling, and distribution may impact upon the integrity of the environment and the health of the civil population. Consequently, the discharge of these agents and their by-products into the environment is regulated by state and federal statutes, standards, and guidelines. Of primary concern are the effluent guidelines and discharge criteria imposed by the U. S. Environmental Protection Agency. Since one of the main areas of concern is the adverse alteration of human health via non-occupational exposure to these compounds, an extensive knowledge of munitions toxicity to man and experimental animal models is an essential prerequisite to the judgmental decisions aimed at predicting low-risk levels of exposure.

Purpose. The objective of this report is to provide any researcher interested in health hazards of munitions compounds with a working bibliography. As with the preparation of any bibliography, there were inherent problems due to the nature of the materials. Therefore, a generalized approach is included, but merely as a recommended starting point.

General Approach. A survey was conducted covering the biomedical and chemical literature of the 19th and 20th centuries. Where possible, computer searches covering literature of 70's were performed. Pertinent abstracting tools and standard reference texts were researched manually. Special resources were also checked. In order to maximize output, the specific approach to each compound was custom designed to coordinate with the retrieval tools. The approach to each reference was adapted to suit the objectives of each tool in order to maximize efforts.

The military munitions included in this literature search were: dinitrotoluene, hexachloroethane, lead styphnate, nitroguanidine, pentaerythritol tetranitrate, potassium chlorate, potassium perchlorate, red phosphorus, tetrazene, and titanium.

The investigation of the munitions in the literature followed a pattern, the first step being the research of the standard reference tools. For each material, lists of (a) synonyms, (b) acute toxicity (e.g., LD50), and (c) general symptomatology were compiled where possible. That information was obtained from the following reference texts:

1. Kirk-Othmer. ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY, Volume 16, 2d rev. ed., edited by Herman F. Mark. New York, Interscience Publishers, 1967, pp. 824-40.

2. DICTIONARY OF ORGANIC COMPOUNDS, 4th ed. New York, Oxford University Press, 1965.

3. Gleason, Marion N., Gosselin, Robert E., Hodge, Harold C. and Smith, Roger P. CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS - ACUTE POISONING. 3d ed. Baltimore, Williams & Wilkins Co., 1969.

4. Sax, N. Irving. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS. 2d ed. New York, Reinhold, 1963.

5. Goodman, Louis S. and Gilman, Alfred. THE PHARMACOLOGICAL BASIS OF THERAPUTICS, 3d ed. New York, MacMillan, 1965.

6. Williams, R. Tecwyn. DETOXICATION MECHANISMS: METABOLISM AND DETOXICATION OF DRUGS, TOXIC SUBSTANCES AND OTHER ORGANIC COMPOUNDS. New York, Wiley, 1959.

7. Browning, Ethyl. TOXICITY OF INDUSTRIAL METALS. 2d ed. New York, Appleton-Century-Crofts, 1969.

8. von Oettingen, W. F. POISONING: A GUIDE TO CLINICAL DIAGNOSIS AND TREATMENT, 2d ed. New York, W. B. Saunders, 1958.

9. Moeschlin, Sven. POISONING, DIAGNOSIS AND TREATMENT. First American Edition Translated by Jenifer Bickel from the Fourth German Edition. New York, Grune & Stratton, 1965.

10. Stewart, C. P. and Stolman, A., editors. TOXICOLOGY, MECHANISM AND ANALYTICAL METHODS. Vol. I 1960, Vol. II 1961. New York, Academic Press.

11. Patty, Frank. INDUSTRIAL HYGIENE AND TOXICOLOGY. Volume II TOXICOLOGY. 2d rev. ed. New York, Interscience, 1962.

12. Urbanski, Tadeusz. CHEMICAL TECHNOLOGY OF EXPLOSIVES. Volume I, 1964, II 1965, III 1967. New York, Pergamon Press.

13. THE MERCK INDEX OF CHEMICALS AND DRUGS, AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS, AND PHYSICIANS, AND MEMBERS OF ALLIED PROFESSIONS. 7th ed. Paul G. Stecher, ed. Rahway, N. J., Merck & Co., Inc., 1960.

Pertinent articles retrieved from the preceding texts were requested and obtained from the NERC-Cincinnati Library.

The University of Cincinnati Medical School, Kettering Laboratory, maintains an extensive chemical reprint file. Many of the materials contained are very old and/or translated into English. Because of this, the Kettering reprint file was also researched. Many of the old citations on chemical warfare were obtained from this source.

The Edgewood Technical Library was another resource which was accessed because it houses classified files pertaining to chemical warfare, largely due to its active role in war efforts. Although the specific documents were still classified, much of the material was old enough to be sufficiently covered in published literature.

Computerized searching was available primarily for the last 4-5 years. Prior to 1970, it was necessary to research the munitions manually. The Defense Documentation Center was contracted with to run a hand search covering 1940-55 of the toxicity of munitions. There were only four references retrieved, all of which were very poor. The unsatisfactory output influenced the decision not to request a second profile.

The bulk of the manual searching was performed through CHEMICAL ABSTRACTS, 1907-1969, BIOLOGICAL ABSTRACTS, 1927-58, and EXCERPTA MEDICA, 1960-1969. Chronologically, terminology used in researching the indices of the abstracting tools changed with editorial policy, with expanding knowledge within the disciplines covered, and with the changing approach to information retrieval. This was amply demonstrated in both CHEMICAL ABSTRACTS and BIOLOGICAL ABSTRACTS as shown in Table 1, in which the search terms throughout 1907-1969 are compared.

TABLE 1 -- General Approach
A. BIOLOGICAL ABSTRACTS

1927	1943	1943	1958
* = not listed			
* dinitrotoluene or DNT	chlorate(s)	phosphorus, red	explosions
* toluene	dinitrotoluene	potassium hypochloride	explosives
* hexachloroethane	explosions	potassium perchlorate	dinitrotoluene
* lead styphnate	explosives	pyrotechnic(s)	guanidine
* styphnic acid	guanidine	resorcinol	hexachloroethane
* guanidine	hexachloroethane	styphnic acid	lead styphnate
* nitroguanidine	lead styphnate	tetracene	nitroguanidine
* pentaerythritol	nitrogen tetranitrate	tetrazene	pentaerythritol tetranitrate
* potassium chlorate	nitroguanidine	titanium	potassium perchlorate
* potassium perchlorate	PETN	toxicity	poisoning
* pyrotechnics	pentaerythritol	toxicology	potassium chlorate
* trinitroresorcinol		tetranitrate	toxin(s) styphnic acid
* tetracene	poison	trinitroresorcinol	trinitroresorcinol
toxicity	poisoning		tetracene toxicity

Table 1 (cont.) -- General Approach

B. CHEMICAL ABSTRACTS

1907	1914	1969	1969
	SECTIONS:		
explosions	Biological Chemistry	explosives	nitro compounds
explosives	Nutrition	explosions	
dinitrotoluene	Physiology	guanidine	
lead styphnate	Pathology	nitroguanidine	
nitroguanidine	Pharmacology	lead styphnate	
pentaerythritol tetranitrate	Pharmaceutical Chemistry	styphnic acid	
potassium chlorate		pentaerythritol tetranitrate or peritrate	
potassium perchlorate	Explosives	potassium chlorate	
styphnic acid		potassium perchlorate	
tetracene		potassium hypochloride	
tetrazene		tetracene or tetrazene	
		titanium	
		poisoning (dropped in 6th Collective Index 1957-61)	
		toxicity	
		alkali metals, perchlorate or alkali metals, hypochloride	
		hexachloroethane	
		toluene, dinitro	
		toluene, dinitro	

DINITROTOLUENE

Specific Approach. Research for data on dinitrotoluene followed the routine search strategy, except during the first few years of CHEMICAL ABSTRACTS. It was not indexed under dinitrotoluent, but was found under "toluene" or "trinitrotoluene." Also noted was an on-going literature evaluation of trinitrotoluene and dinitrotoluene as waste products from munitions manufacture, which was also under Army contract. In view of this fact, research was limited to readily retrieved information. Data obtained on DNT was from straightforward chemical name searching and research via the CHEMICAL ABSTRACTS registry number. Terms used in the computer strategy demonstrate this approach and can be found below.

Chemistry. Dinitrotoluene (MW = 182.1) occurs in the following isomeric forms:

2,3-dinitro-1-toluene
2,4-dinitro-1-toluene
2,5-dinitro-1-toluene
2,6-dinitro-1-toluene
3,4-dinitro-1-toluene
3,5-dinitro-1-toluene

Each is considered relatively insoluble in water; however, one source (20) states that the solubility is 300 mg/l at 22 degrees C. Only the pure 2,4-dinitro-1-toluene is believed to be used in explosives.

SPECIFIC SEARCH TERMS

dinitrotoluene
DNT
nitrocompounds and toluenes
CAS # 25321-14-6 # 121-14-2
#34063-52-0 # 619-15-8
1610-26-0 # 618-85-9
602-01-7 # 610-39-9
606-20-2

These terms or descriptors tailored the research in the data bases specifically for dinitrotoluene. However, there was a fundamental approach used for all compounds, so that coordination of any descriptor in the basic format with each compound name retrieved the specific data being researched.

The data bases, period covered and descriptors used in computerized retrieval are demonstrated in Table 2. Since the same computerized search procedure was used for all compounds, this table is not repeated for any of the other compounds, except PETN.

TABLE 2

DINITROTOLUENE

DATA BASES	PERIOD COVERED	SEARCH TERMS
1. TOXLINE - Informatics, Inc.	1970-1974 (includes update)	dinitrotoluene or DNT CAS#25321-14-6 #121-14-2 #34063-52-0 #619-15-8 #1610-26-0 #606-20-2 #602-01-7 #618-85-9 #610-39-9 poisoning toxicity LD oral ingestion inhalation dermatitis explosive(s) explosion(s) munitions
2. MEDLINE - National Library of Medicine (now possesses capability of research with CAS#, which was not possible at the time this search was conducted)	1970 - 1974 (includes update)	nitro compounds and toluenes adverse effects/poisoning/ toxicity biotransformation hypersensitivity occupational diseases industrial medicine carcinogens or neoplasms

TABLE 2 (cont'd)

DINITROTOLUENE

DATA BASES	PERIOD COVERED	SEARCH TERMS
3. CAC - Batelle (Chemical Abstracts Condensates	Jan. 1971 - Jan. 1974 (includes update)	dinitrotoluene DNT adverse poisoning toxic or toxicity lethal explosives or explosions detonation or detonating combustion or combustability pyrotechnics safety health bone or blood or liver or heart carcinogen or neoplasm or cancer or tumor cardiovascular or respiration or respiratory
4. CHEMCON - Systems Development Corp.	June 1971 - Jan. 1974 (includes update)	dinitrotoluene DNT adverse poisoning toxic or toxicity lethal explosives or explosions detonation or detonating combustion or combustability pyrotechnics safety health bone or blood or liver or heart carcinogen or neoplasm or cancer or tumor cardiovascular or respiration or respiratory

TABLE 2 (cont'd)

DINITROTOLUENE

DATA BASES	PERIOD COVERED	SEARCH TERMS
5. NTIS	1971 - 1973	dinitrotoluene or DNT toxicity poisoning lethal dose adverse effects environ/mental industrial hygiene/hygiene safety handling hazard(s) occupational health explosive(s) munitions/industry combustion products characterization determination composition ingestion inhalation breathing dermatitis skin
6. BA - Biosis, Inc. Biological Abstracts	1959 - June 1973	dinitrotoluene or DNT poisoning toxicity LD50

DINITROTOLUENE
BIBLIOGRAPHY

1. von Oettingen, W. F. The aromatic amino and nitro compounds, their toxicity and potential dangers. Public Health Bulletin No. 271. Washington, D. C., Government Printing Office, 1941. pp. 108-09.

2. White, R. P., Hay, J., and Orsman. Some notes from an inquiry into the action of dinitro-benzene upon the urine of man. Lancet 160: 1393, 1902.

3. Kuhls. Quantitative experiments on the absorption of poisons through the skin. INAUG. DISSERT. WURZBURG, 1905.

4. Dambleff, J. On the knowledge on the toxic action of nitrated benzenes especially from the skin. INAUG. DISSERT. WURZBURG., 1908.

5. Zieger, J. Studies on the effect of nitrobenzene, dinitro-benzene, nitro-toluene, and dinitro-toluene with absorption through the lungs and skin. INAUG. DISSERT. WURZBURG, 1913.

6. Clayton, C. C. and Baumann, C. A. Some effects of diet on resistance of mice toward 2,4-dinitrotoluene. Arch. Biochem. 5: 115-20, 1944.

7. Clayton, C. C. and Baumann, C. A. Effect of fat and calories on resistance of mice to 2,4-dinitro-toluene. Arch. Biochem. 16: 415-22, 1948.

8. Shils, Maurice E. and Goldwater, Leonard J. Influence of dietary protein and fat on the toxicities of tri-nitrotoluene (TNT) and 2,4-dinitrotoluene (DNT) for the rat. Fed. Proc. 8: 397, 1949. (Abstract only)

9. Gleason, Marion N., Gosselin, Robert E., Hodge, Harold C. and Smith, Roger P., ed. CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS, ACUTE POISONING. 3d ed. Baltimore, Williams & Wilkens, 1969, p. 59.

10. Koelsch, F. Contributions to the toxicology of aromatic nitro compounds. Zentr. Gewerbehyg. Unfallverhut. 5: 60, 65, 98, 109, 142, 1917.

11. Perkins, R. G. Study of the munitions intoxication in France. U. S. Public Health Reports 34. Washington, D. C., Government Printing Office, October 1919, p. 2335.

12. Floret. Medical opinions on industrial poisonings. Centr. Gewerbehyg. Unfallverhut. 16: 280, 1929.

13. Lewin, L. Poisoning from trinitro-toluene. Arch. Exptl. Path. Pharmakol. 89: 340, 1921.

14. Friedlander, A. On the clinical picture of poisoning with benzene and toluene derivatives with special reference to the so-called anilinism. Neurol. Centrlbl. 19: 155, 294, 1900.

15. McGee, Lemuel C., McCausland, Alexander, Plume, C. A. and Marlett, N. C. Metabolic disturbances in workers exposed to dinitrotoluene. Am. J. Digestive Diseases 9: 329-32, 1942.

16. cGee, Lemuel C. Some occupational disease hazards in munitions manufacture. (Presented at 31st National Safety Congress Transactions, October 29, 1942.)

17. McGee, Lemuel C., Reed, Howard L., Nereim, Theodore J., Plume, C. A. and McCausland, Alexander. Metabolic disturbances in workers exposed to dinitrotoluene during World War II. Gastroenterology 8: 293-95, 1946.

18. White, R. P. and Hay, John. Some recent inquiries and research into the poisonous properties of Naphthalene and the aromatic compounds. Lancet 2: 582-84, 1901.

19. Courtois-Suffit. Toxicologie du dinitrotoluene et pathologie des ouvriers le manipulant. Arch. Maladies Professionelles 1: 294-97, 1939.

20. Galuzova, L. B. Hygienic basis for the maximum permissible concentration of dinitrotoluene in the water of a water expanse. Giz. i. San. 28(2): 14-19, Feb. 1963. (Translation)

DINITROTOLUENE
UNCITED REFERENCES

1. McConnell, W. J. and Hinn, Robert H. Summary of twenty-two trinitrotoluene fatalaties in World War II. J. Indus. Hyg. & Toxicol. 28: 76-86, 1946.

2. MIL-D-204A Military Specification - Dinitrotoluene for Use in Explosives. Washington, D. C., G.P.O., August 1963.

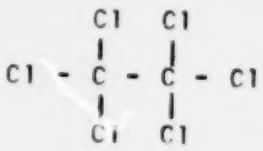
3. Plunkett, E. R. HANDBOOK OF INDUSTRIAL TOXICOLOGY. New York, Chemical Publishing Co., 1966, pp. 153-54.

HEXACHLOROETHANE

Specific Approach. Computer searching was conducted (as outlined in Table 2 in DNT section) in order to compile all correlative, pertinent material concerning hexachloroethane. Specific search terms included hexachloroethane, perchloroethane, carbon hexachloride, chlorinated hydrocarbons, or CAS #67-72-1.

This material was searched directly under the generic term, "hexachloroethane," and under its synonyms, perchloroethane or carbon hexachloride. Because of the target organs identified in the general reference tools, it was necessary to coordinate hexachloroethane with specific biological terms (e.g., ingestion, inhalation, and dermatitis). In coordinating hexachloroethane with any of the munitions-related terms (e.g., explosive(s), explosion(s), munitions, munitions industry) there was little success other than military documents. Although, there were no searching difficulties encountered, the information retrieved was principally oriented to veterinary medicine.

Chemistry. Hexachloroethane has a molecular weight of 236.7, exists in the form of rhombic chrystals, and possesses a solubility in water of 0.005 grams per 100 ml at 22 degrees C (1,2). The structure of this compound is shown below.



Hexachloroethane has been used not only as an explosive but also as a veterinary anthelminthic with specific application against Fasciola hepatica (3-5).

HEXACHLOROETHANE
BIBLIOGRAPHY

1. THE MERCK INDEX OF CHEMICALS AND DRUGS, AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS, AND PHYSICIANS, AND MEMBERS OF ALLIED PROFESSIONS. 7th ed. Paul G. Stecher, ed. Rahway, N. J., Merck Co., Inc. 1960, pp. 514.

2. Patty, Frank A., Editor. INDUSTRIAL HYGIENE AND TOXICOLOGY. 2nd rev. ed. Volume II Toxicology. New York, Interscience Publishers, 1962, pp. 1297-98.

3. Pegreffi, G. (Treatment of liver fluke disease by carbon tetrachloride and hexachloroethane.) Clin. Vet. (Milan) 62:113-20, 172-178, 1939. (BA20: 1905, 1946).

4. Olsen, O. Wilford, Hexachloroethane-bentonite suspension for controlling the common liver fluke, Fasciola LePatica, in cattle in the Gulf Coast region of Texas. Amer. J. Vet. Res. 8(29): 353-66, 1947. (BA22:12688, 1948).

5. Olsen O. Wilford. Critical tests with a hexachloraethane-bentonite-water suspension as a fasciolicide in cattle. J. Parasit. 30 Suppl. 14:14, 1944.

6. Williams, R. Tecwyn. DETOXICATION MECHANISMS-METABOLISM AND DETOXICATION OF DRUGS, TOXIC SUBSTANCES AND OTHER ORGANIC COMPOUNDS. 2nd rev. ed., New York, John Wiley & Sons, Inc. 1959, pp. 30-31.

7. Barsoum, G.S. and Saad, K. Toxicities of the chlorine derivatives of the aliphatic series. Quart. J. Pharm. Pharmacol. 7:205, 1934.

8. Maloff, G.A. (Studies on the toxicology of chlorine derivatives of methane and ethane. Arch. Exp. Path. U. Pharmakol. 134(3/4): 168-72, 1928. (BA4:21587, 1930).

9. Fowler, J.S.L. Some hepatoxic actions of hexachloroethane and its metabolites in sheep. Br. J. Pharmac. 35:530-42, 1969.

10. Southcott, W.H. Toxicity and antihelmintic efficiency of hexachloroethane in sheep. Aust. Vet. J. 27:18-21, Jan. 1951.

11. Byewater, H.E. Toxicity of hexachloroethane. Vet. Rec. 67:282, May 14, 1955. (Letters to Editor).

12. Jondorf, W.R., et al. Metabolism of (C) hexachloroethane. Biochem. J. 65(2):14P-15P, 1957.

13. Fowler, J.S.L. Chlorinated hydrocarbon toxicity in the fowl and duck. J. Comp. Path. 80:465-71, 1970.

14. Threshold Limit Values of Airborne Contaminants and Intended Changes, Adopted by ACGIH for 1970. Cincinnati, American Conference of Governmental Industrial Hygienists, 1970, p. 10.

15. Plotnikov, N. N., and Sokolov, L. N. Pharmacological properties of hexachloroethane. Farmakol. i. Toksikol. 10(2): 47-51, 1947. (CA41:7535f).

16. Panasyuk, D. I. Action of hexachloroethane (fasciolin) on the horse. Isdatel. Akad. Nauk. S.S.S.R. pp. 470-82, 1953. (CA50:5915g)

HEXACHLOROETHANE
UNCITED REFERENCES

1. Barber, G.W. New control methods for the corn ear worm. J. Econ. Ent. 31(3):49, 1938. (BA:12046, 1938).

2. Fowler, J.S.L. Carbon tetrachloride metabolism in the rat. Br. J. Pharmac. 37:733-37, 1969.

3. Gleason, Marion N., Gosselin, Robert E., Hodge, Harold C., and Smith, Roger P., ed. CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS - ACUTE POISONING, 3rd ed. Baltimore, Williams & Wilkins Co., 1969, p. 76.

4. Jarvis, A. Combustion reactions of a pyrotechnic white smoke composition. Combustion & Flame 14:313-20, 1970.

5. Plunkett, E.R. Hexachloroethane. In: HANDBOOK OF INDUSTRIAL TOXICOLOGY. New York, Chemical Publishing Co., 1966, pp. 205-06.

6. AD 266 364 Reaves, Woodrow, W., et al. Comparison of dechlorane and hexachloroethane in smokescreen composition. (CRDL Special Publication 1-37). NTIS, 1960.

7. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS. 2nd ed. New York, Reinhold Publishing Co., 1963, p. 871.

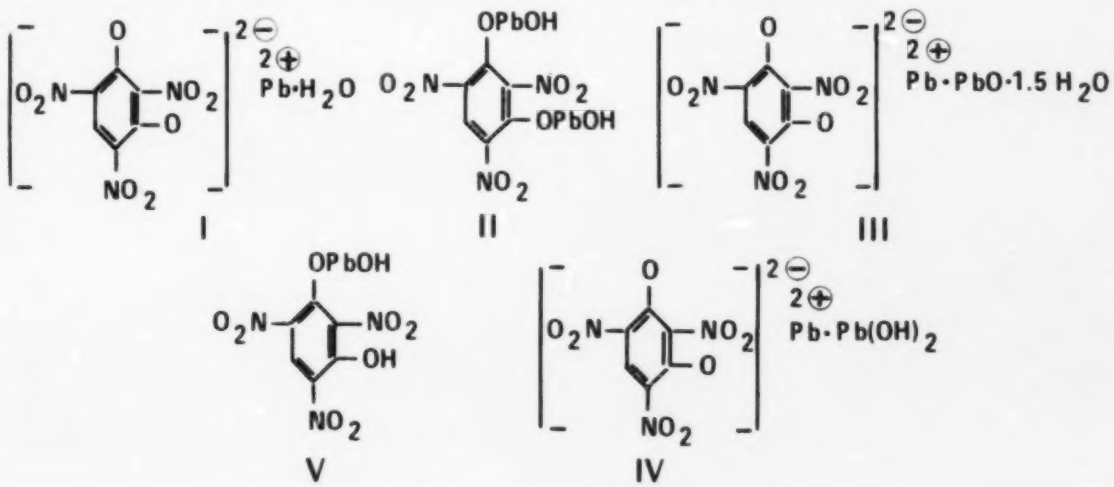
8. AD 474 403 Weeks, Maurice H., et.al. Toxicity of combustion products of pyrotechnics. DDC, 1960.

LEAD STYPHNATE

Specific Approach. Lead styphnate or lead trinitroresorcinate proved frustrating to research. The compound was treated in all discussions of explosives, i.e., Kirk-Othmer ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY and Urbanski's CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, but treatment was limited to its manufacture and use. In querying the biomedical and toxicological data bases, the terms styphnic acid and trinitroresorcinol and lead were coordinated and still provided no new data. As noted in Table 2, in DNT section, the terms searched in Chemical Abstracts also included dihydroxytrinitrobenzene, which yielded chemically oriented material, as would be expected. Sax, DANGEROUS PROPERTIES OF INDUSTRIAL COMPOUNDS, suggests that the toxicity of lead styphnate is actually that of lead and nitrates. The only other specific descriptor is its Chemical Abstracts registry number, CAS #4219-19-6. Also searched were nitrates, nitro compounds, nitroso compounds, or nitrogen oxides.

Chemistry. Lead styphnate, also called lead trinitroresorcinate, is a reddish-brown powder if a neutral salt or a yellow powder if a basic salt (1). Its solubility in water is 0.04 g per 100 ml at 15 degrees C. Depending upon the pH during synthesis of this compound, five structures are possible. The five structures of the lead styphnate salts are shown below.

LEAD STYPHNATE



Since these compounds are salts, dissociation in aqueous solution might be expected; however, no information is available on this property.

LEAD STYPHNATE
BIBLIOGRAPHY

1. Urbanski, Tadeusz. CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, Vol. III. New York, Pergamon Press, 1967, pp. 213-18.

2. Schwartz, Louis S., et. al. - OCCUPATIONAL DISEASES OF SKIN. 3d ed.., Lea and Febiger, Philadelphia, 1957, 453-455.

3. Schwartz, Louis, S. Skin hazards in American industry, Part III. Public Health Bulletin No. 249. Washington, D. C., Government Printing Office, 1939, pp. 88-89.

LEAD STYPHNATE

UNCITED REFERENCES

1. Bremner, Ian. Heavy metal toxicities. Lead. Quarterly Reviews of Biophysics 7(1):103, 1974.

2. Browning, Ethyl. TOXICITY OF INDUSTRIAL METALS. 2d ed. New York, Appleton-Century-Crofts, 1969, pp. 172-187.

3. Glowiak, B. Lead salts of aromatic azides. Bulletin De L'Academie Polonaise Des Sciences. Series Des Sciences Chimiques. Vol. VIII(1):5, 1960.

4. Hoover, William L., et. al. - Metals & other elements. J.A.O.A.C. 52(4): 108, 1969.

5. Johnstone, Rutherford T. A re-examination of the picture of plumbism. Ind. Med. Surg. 26: 323-26, 1957.

6. Kirk-Othmer. ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY, 2d rev. ed. Herman F. Mark, editor. New York, Interscience Publishers, 1967, Volume 8, p. 590.

7. THE MERCK INDEX OF CHEMICALS AND DRUGS AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS AND PHYSICIANS AND MEMBERS OF ALLIED PROFESSIONS. 7th ed. Paul G. Stecher, ed. Rahway, N.J., Merck & Co., Inc., 1960.

8. Rosen, Bernard. The Lead Styphnate Jelly. J.A.C.S. 77: 6517, 1955.

9. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2d ed. New York, Reinhold Publishing Co., 1963, pp. 937, 931-32, 1033-34.

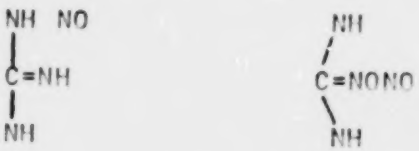
10. Taylor, Wilfrid. MODERN EXPLOSIVES. London the Royal Institute of Chemistry, Lectures, Monographs and Reports, 1959, 1-63 (also includes PETN & Tetrazene).

11. Williams, R. Tecwyn. DETOXICATION MECHANISMS - METABOLISM AND DETOXICATION OF DRUGS, TOXIC SUBSTANCES AND OTHER ORGANIC COMPOUNDS. 2d rev. ed. New York, John Wiley & Sons, Inc., 1959, p. 713.

NITROGUANIDINE

Specific Approach. In researching the literature for information regarding nitroguanidine, no real syntactical problems were encountered, but not much information was located either. Nitroguanidine was discussed and indexed as "nitroguanidine", per se, in the standard reference tools identified in the General Approach Section. However, nitroguanidine was not originally indexed in CHEMICAL ABSTRACTS making it necessary to search under the stem, guanidine, as well. In the (CA)DECENNIAL INDEX 1937-46, nitroguanidine, per se, was referenced for the first time. Based on these difficulties, both the fragment, guanidine, and the inverted name, guanidine-nitro were initially included in computer strategy. Chemically, the preparation and manufacture were available, but mammalian toxicity of nitroquanidine imposed more difficulty. However, it was possible to obtain a manufacturer's report of its limited toxicity studies on nitroquanidine, (American Cyanamid). Other specific coordinate terms include picrite, nitrates, nitro compounds, nitroso compounds, nitrogen oxides or CAS #556-88-7.

Chemistry. Nitroguanidine, which has a molecular weight of 104, is a fine white powder (1). It exists in two tautomeric forms shown below:



At 25 degrees C, the two forms have the same solubility in water of 4.4 grams per 100 grams of water (2). Nitroguanide is relatively stable in water particularly at alkaline pH which favors the slow reaction from the nitrimine to the nitroguanidine (3).

NITROGUANIDINE
BIBLIOGRAPHY

1. Nitroguanidine (Picrite): Limited Release Toxicity Studies. American Cyanamid Company Report No. 54-12 Dec., 1954.

2. Urbanski, Tadeusz. CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, Volume III, New York, Pergamon Press, 1967, pp. 22-23, 29-31.

3. Amos, A.A. Acidity of nitroguanidine and its homologues. Can. J. Chem. 39:1787-96, 1961.

4. Fastier, F.N. and Smirk, F.H. Circulatory properties of isothioureas, guanidines, isoureas, and amidines. J. Pharmacol & Exp. Ther. 89:256-70, 1947.

NITROGUANIDINE

UNCITED REFERENCES

1. Brandt, Warren W., et.al. Reduction of nitroguanidine by titanium (III) chloride. Anal. Chem. 27:392-95.

2. Dieke, Sally H., et.al. Acute toxicity of thioureas and related compounds to wild and domestic Norway rats. J. Pharmacol. & Exp. Ther. 90:260-70, 1947.

3. Kirk-Othmer ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY. 2nd rev. ed. Herman F. Mark, editor. New York, Interscience Publishers, (1967) Volume 8, pp 625-26, Volume 11, p. 740.

4. THE MERCK INDEX OF CHEMICALS AND DRUGS, AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS, AND PHYSICIANS AND OTHER MEMBERS OF ALLIED PROFESSIONS. 7th ed. Paul G. Stecher, ed. Rahway, N.J., Merck Co., Inc., 1960, p. 728.

5. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2nd ed. New York, Reinhold Publishing Co., (1963), p. 1045.

PENTAERYTHRITOL TETRANITRATE

Specific Approach. Computer searching strategy is outlined in Table 3.

In this instance, standardized research procedure seemed insufficient. From the retrieval, it was determined that pentaerythritol tetranitrate had current clinical application. Therefore, contact was made with the Food and Drug Administration, and Warner/Chilcott, the manufacturer of the currently used drug, Peritrate®. Consultation with Dr. Arthur D. Flannagan, Vice President of Medical Affairs, provided ample data for this report when reviewed in conjunction with the other material retrieved.

Chemistry. Pentaerythritol tetranitrate, PETN, peritrate, penthrite, Hasethrol, isa powerful explosive and therapeutic agent. It is the nitric acid ester of the quadrivalent alcohol, pentaerythritol, and has the structural formula:

It has a molecular weight of 316.05 and represents a white crystaline material with a specific gravity of 1.67 and a melting point of 140 degrees C (1). Its solubility in water is 2 mg/l (3), being much more soluble in acetone or alcohol.

A colorimetric determination of PETN was described by Allert (4) in 1948, and later semi-automatic electric titration was developed (5).

PETN BIBLIOGRAPHY

1. von Oettingen, W. F. Effects of aliphatic nitrous and nitric acid esters on physiological functions with special reference to chemical constitution. Public Health Bulletin 186. Washington, D. C., Government Printing Office, 1946.

2. Dunning, A. J., editor. PENTAERYTHRITOL TETRANITRATE: A REVIEW OF WORLD-WIDE SCIENTIFIC LITERATURE ON PHARMACOLOGY AND CLINICAL EXPERIENCE 1943-1969. Princeton, Excerpta Medica, 1971.

3. Merrill, E. J. Solubility of pentaerythritol-1,2,- C tetranitrate in water and saline. J. Pharm. Sci. 54(11): 1670, 1965.

4. Allert, J. Determination of pentaerythritol tetranitrate and a mixture of nitroglycerol in tablets. Dansk. T. Farm. 22:188, 1948.

5. Sandi, S. and Flanquart, G. Determination of nitrate content, content of nitrates, nitrocellulose, and explosives, such as nitroglycerin and pentaerythritol tetranitrate. Chim. Anal. 39: 20, 1957.

6. Lawton, A. H., et. al. Toxicity and potential dangers of pentaerythritol tetranitrate (PETN). Public Health Bulletin No. 282. Washington, D. C., Government Printing Office, 1944, p. 19.

7. DiCarlo, Frederick J., Coutinho, Claude, B., Sklow, Nancy J., Haynes, Lloyd J., and Crew, Malcolm C. Binding of pentaerythritol tetranitrate and its metabolites by rat blood plasma and erythrocytes. Proc. Soc. Exp. Biol. Med. 120: 705, 1965.

8. DiCarlo, F. J., et. al. Absorption and biotransformation of pentaerythritol tetranitrate - 1,2-C by rats. Biochem. Pharmacol. 16 309

9. DiCarlo, F. J., et. al. Incorporation of radioactivity from nitroglycerin C into rat liver glycogen, lipid, protein ribonucleic acid and deoxyribonucleic acid. Biochem. Pharmacol. 18:1985, 1969.

10. DiCarlo, F. J., et. al. Absorption of pentaerythritol tetranitrate by the mouse. Life Sci. 3(6):563, 1964.

11. DiCarlo, F. J., et. al. Metabolism of pentaerythritol trinitrate and pentaerythritol by dogs. J. Pharmacol. Exp. Ther. 168(2):235, 1969.

12. DiCarlo, F. J., et. al. Metabolism of pentaerythritol tetranitrate by patients with coronary artery disease. J. Pharmacol. Exp. Ther. 153(2):254, 1966.

13. von Oettingen, W. F., et. al. Toxicity and potential dangers of pentaerythritol tetranitrate (PETN). Public Health Bulletin No. 282. Washington, D. C., Government Printing Office, 1944, p. 22.

14. Ibid., p. 21.

15. DiCarlo, F. J., et. al. Sites of absorption of pentaerythritol by the rat. Fed. Proc. 24(2), 1965.

16. DiCarlo, F. J., et. al. Biotransformation of pentaerythritol tetranitrate by parenchymal and reticuloendothelial cells of mouse liver. J. Reticuloendo. Soc. 4:24, 1967.

17. DiCarlo, F. J., et. al. Absorption and biotransformation of pentaerythritol tetranitrate - 1,2-C by rats. Biochem. Pharmacol. 16:309, 1967.

18. Leinweber, Franz-Josef, Melgar, Myriam D., Crew, Malcolm C., and DiCarlo, Frederick J. Isolation of pentaerythritol nitrates and their glucuronides. Drug Metabolism and Disposition 2(1): 40, 1974.

19. Crew, Malcolm C., Gala, Rosemarie L., Haynes, Lloyd J., and DiCarlo, Frederick J. Biliary excretion and biotransformation of pentaerythritol trinitrate in rats. Biochem. Pharmacol. 20: 3077, 1971.

20. Melgar, Myriam D., Leinweber, Franz-Josef, Crew, Malcolm C., and DiCarlo, Frederick J. Denitration of unconjugated and conjugated pentaerythritol nitrates by rat liver cytosol. Drug Metabolism and Distribution 2(1): 46, 1974.

21. DiCarlo, F. J., et. al. Binding of pentaerythritol tetranitrate and its metabolites by rat blood plasma and erythrocytes. Proc. Soc. Exp. Biol. Med. 120:705, 1965.

22. Ibid., p. 514.

23. DiCarlo, F. J., et. al. Binding of pentaerythritol tetranitrate and its metabolites by rat blood plasma and erythrocytes. Proc. Soc. Exp. Biol. Med. 120:705, 1965.

24. Needleman, P. and Hunter, F. E., Jr. The transformation of glyceryl trinitrate and other nitrates by glythione - nitrate reductase. Molec. Pharmacol. 1:77, 1965.

25. DiCarlo, F. J., et. al. Sites of absorption of pentaerythritol tetranitrate. Arch. Int. Pharmacodyn. 170(2):453, 1967.

26. Litchfield, M. H. Aspects of nitrate ester metabolism. J. Pharm. Sci. 60(11): 1599, 1971.

27. Cass, Leo J., et. al. Metabolic fate of nitrate esters. Angiology 13:469, 1962.

28. Cass, L. J., et. al. The Application of new chemical techniques in clinical research of coronary diseases. Angiology 14(10): 556, 1963.

29. Ikawa, Yutaka, Tanaka, Shozo, and Miyata, Sadao. The metabolism of pentaerythritol tetranitrate. Wakayama Med. Repts. 4: 185, 1959. (CA54:11284i.)

30. DiCarlo, F. J., Coutinho, C. B. and Crew, M. C. Sites of absorption of pentaerythritol tetranitrate. Arch int Pharmacodyn 167(1): 163, 1967.

31. Davidson, I. W. F., Miller, Henry S., Jr., and DiCarlo, Frederick J. Absorption, excretion and metabolism of pentaerythritol tetranitrate by humans. J. Pharmacol. Exp. Ther. 175(1): 42, 1970.

32. Davidson, Ivan W. F., Miller, Henry S., Jr., and DiCarlo, Frederick J. Pharmacodynamics and biotransformation of pentaerythritol tetranitrate in man. J. Pharm. Sci. 60(2): 274, 1971.

33. von Oettingen, W. F. and Donahue, D. D. Toxicity and potential dangers of pentaerythritol tetranitrate (PETN). Public Health Bulletin No. 282. Washington, D. C., Government Printing Office, 1944, p. 23.

34. Patty, Frank. INDUSTRIAL HYGIENE AND TOXICOLOGY, Volume 2, Toxicology 2d rev. ed., New York, Interscience Publishers, 1962, p. 2097.

35. Bogaert, M. G. and DeSchaepdryver, A. F. Dopamine-induced neurogenic vasodilation in the hindleg of the dog. Arch. int. Pharmacodyn 171:221, 1968.

36. Nickerson, Mark. In: THE PHARMACOLOGICAL BASIS OF THERAPUTICS, 4th ed. Louis S. Goodman and Alfred Gilman, Ed. Macmillan, New York, 1965, p. 750.

37. Donahue, D. D. & Monaco, A. R. Toxicity and potential dangers of pentaerythritol tetranitrate (PETN). Public Health Bulletin No. 282. Washington, D. C., Government Printing Office, 1944, p. 30.

PETN UNCITED REFERENCES

1. Bender, A. D., Sullivan, F. J., and Hovarth, S. M. Effects of continued pentaerythritol tetranitrate administration on myocardial circulation and metabolism. Experientia 19: 254, 1963.

2. Blum, S. W., Quinn, J. B., and Dubnick, B. Effects of Petrin and other organic nitrates on rat heart mitochondrial activities. Fed Proc. 28(2): 479, 1969. (abstract only.)

3. Blum, S. W., et. al. Pharmacologic and biochemical evaluation of organic nitrates: attempted correlation of activities. J. Pharmacol Exp. Ther. 176(3): 684, 1971.

4. Cummins, Alvin J. Esophageal obstruction by water-insoluble medication. (Letter to the Editor.) J.A.M.A. 196(10): 209, 1966.

5. DiCarlo, Frederick J. Biotransformation of pentaerythritol tetranitrate as related to host-defense reactions. J. Reticuloendo. Soc. 4: 190, 1957.

6. Frohlich, Edward D., et. al. Effects of glyceryl trinitrate and pentaerythritol tetranitrate on forelimb, renal, mesenteric and total peripheral resistances. Amer. Heart J. 70(5): 657, 1965.

7. Hirshleifer, Irving. Clinico-pharmacologic comparison of nitrates. Western Med. 4: 263, 1963.

8. Hueper, W. C. and Lansberg, J. W. Experimental studies in cardiovascular pathology. Arch. Pathol. 29: 633, 1940.

9. Litchfield, M. H. Aspects of nitrate ester metabolism. J. Pharm. Sci. 60(11): 1599, 1971.

10. Lonadier, F. O., Hedley, W. H., and Haws, L. D. Biodegradability of explosives. Monsanto Research Corp., Mounds Laboratory, Miamisburg, Ohio, for Atomic Energy Commission under Contract No. AT-33-1-GEN-33.

11. Mann, Hubert. Comparative study of vasodilators by objective method. J. Mt. Sinai Hosp., N. Y. 25: 543, 1958.

12. McConnel, William J., et. al. Occupational diseases in government-owned ordnance explosives plants. Occupational Med. 1: 551, 1946.

13. Newell, D. J. et. al. Pentaerythritol tetranitrate (sustained action) in acute myocardial infarction. Br. Heart J. 32: 16, Jan. 1970.

14. Russek, Henry I. Evaluation of vasodilator drugs. Postgrad Med. 19: 562, 1956.

15. Ryan, F. P. Erythroderma due to peritrate and glyceryl trinitrate. Br. J. Derm. 87: 498, 1972.

16. Stirpe, Dante, et. al. Shock initiation of XTX-8003 and pressed PETN. J. Appl. Phys. 41(9): 3884, 1970.

17. Sullivan, J., et. al. Acute effects of pentaerythritol tetranitrate on various myocardial, hemodynamic, and metabolic parameters in normal anesthetized dogs. Arch. int. Pharmacodyn. 147(1/2): 229, 1964.

18. Teregulov, G. N., et. al. Clinical use of pentaerythritol tetranitrate in angina pectoris. SB Nauch Tr Bashkirskogo Med. Inst. 15(1): 158-61, 1965 (BA54347, 1967.)

19. Uchida, Yasumi, et. al. Effect of pentaerythritol tetranitrate on blood flow through the ischemic and non-ischemic myocardium. Jap. Heart J. 13(6): 502, 1972.

20. Winbury, Martin M. and Gabel, Lloyd P. Effects of nitrates on nutritional circulation of heart and hindlimb. Amer. J. Physiol. 212: 1062, 1967.

21. Winbury, Martin M., et. al. Pentaerythritol tetranitrate and dipyrimadole on cardiac nutrition flow and blood content. Amer. J. Physiol. 220(5): 1558, 1971.

22. Winsor, Travis and Hymphreys, Patrick. Influence of pentaerythritol tetranitorate (Pernitrate) on acute and chronic coronary insufficiency. Angiology 3: 1, 1952.

23. THE MERCK INDEX OF CHEMICALS AND DRUGS AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS, AND PHYSICIANS, AND MEMBERS OF ALLIED PROFESSIONS. 7th ed. Paul G. Stecher, ed. Rahway, N. J., Merck Co., Inc., 1960, p. 780.

POTASSIUM CHLORATE

Specific Approach. Research for the toxicity of potassium chlorate was a relatively straight-forward process as its use has been widespread and results have been published. Potassium chlorate was indexed as an entity, often with an additional reference to "see chlorates." In a few instances, except Gleason's CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS, and von Oettingen's POISONING, A GUIDE TO CLINICAL DIAGNOSIS AND TREATMENT, was the compound treated solely according to one component. However, in the abstracting indices as well as in the standard reference texts, the "chlorate(s)" category was also investigated for material pertinent to a compound class reaction or specifically to potassium chlorate. In manual searching, it was unnecessary to coordinate potassium chlorate with toxicity or with poisoning because this compound was well documented. In view of target sites of potassium chlorate, specific biological terms (e.g. blood, liver and kidney) were coordinated in the computer strategy. The only other descriptor for potassium chlorate was the Chemical Abstracts registry number, CAS #3811-04-9.

Chemistry. Potassium chlorate, $KClO_3$, has a molecular weight of 122.6. It exists either as transparent, colorless crystals or as a white powder (1). It has been used as a dentrifice, a disinfectant, an astringent, an oxidizing agent, and a munition.

POTASSIUM CHLORATE
BIBLIOGRAPHY

1. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2d ed. New York, Reinhold Publishing Co., 1963, pp. 1119, 593-94.

2. Gleason, Marion N., Gosselin, Robert E., Hodge, Harold C., and Smith, Roger P., ed. CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS, ACUTE POISONING. 3d ed. Baltimore, Williams & Wilkens, 1969, p. 33.

3. von Oettingen, W. F. POISONING A GUIDE TO CLINICAL DIAGNOSIS AND TREATMENT. 2d ed. Philadelphia, W. B. Saunders Co., 1958, pp. 291-92.

4. Goodman, Louis S. and Gilman, Alfred. THE PHARMACOLOGICAL BASIS OF THERAPUTICS. 4th ed. New York, Macmillan Co., 1970, p. 1047.

5. Moeschlin, Sven. POISONING DIAGNOSIS AND TREATMENT. First American Edition Translated by Jenifer Bickel from the Fourth German Edition. New York, Grune & Stratton, 1964, pp. 215-16.

6. Bodansky, Oscar. Methemoglobinemia and methemoglobin-producing compounds. Pharmacol. Rev. 3: 174, 1951.

7. Marchand, F. Ueber die giftige Wirkung der Chlorsauren Salze. Arch. f. Exper. Path. U. Pharmakol. 23: 273-315, 1887.

8. Richardson, A. P. Toxic potentialities of continued administration of chlorate for blood and tissue. J. Pharmacol. & Exper. Therap. 59: 101-113, 1937.

9. Heubner, W. V. and Jung, F. Zur Theorie der Chloratvergiftung. Schweiz. Med. Wchnschr. 71: 247-50, 1941.

10. Jung, F. Zur analyse der Chloratvergiftung. Klin. Wchnschr. 22: 43, 1943.

11. Becker, T., Dordoni, F., and Jung, F. Zur Theorie der Chloratvergiftung. II. Arch. f. Exper. Path. U. Pharmakol. 201: 197-209, 1943.

12. Ulrich, John L. and Shternov, Vladmir. Comparative action of solutions of the chlorates and chlorides of potassium, sodium, calcium and magnesium. J. Pharmacol. Exp. Ther. 35(1): 1-15, 1929.

13. Ulrich, John L. and Shternov, Vladmir A. Action of chlorates, in particular potassium chlorate, on blood in animals. J. Pharmacol. Exp. Ther. 34: 391-406, 1928.

14. Witthaus, R. A. MANUAL OF TOXICOLOGY. New York, William Wood and Co., 1911, pp. 690-701.

15. Reiss, L. Potassium chlorate poisoning and remarks on the excretion of hemoglobin through the kidneys. Arch. Exp. Pathol. Pharmakol. p. 460, 1908. (CA3:209, 1909.)

16. Lehnert, F. Fatal poisoning by means of potassium chlorate in the case of a Gravida. Beitr. Path. Anat. 54: 443, 1912. (CA7:827, 1913.)

17. Bachem, C. Is the use of potassium chlorate tooth paste dangerous. Munch. Med. Wochschr. 59: 2165, 1912. (CA7:154, 1913.)

18. Fisher, Howard J., Drommond, Fred G. and Poe, Charles F. Toxicity of potassium chlorate for the white rat. Univ. Colo. Studies, Ser. Chem. Pharm. 2: 23-8, 1959.

19. Joseph, D. R. and Meltzer, S. J. Relative toxicity of Mg, Ca, K, and Na. Proc. Soc. Exper. Biol. Med. V: 85, 1907.

20. Joseph, D. R. and Meltzer, S. J. Inhibitory action of NaCl on phenomena following removal of parathyroids in dogs. Proc. Soc. Exper. Biol. Med. VIII: 26, 1909-1910.

21. Gordon, Susanna and Brown, J. A. H. Potassium chlorate poisoning. Lancet 253: 503, 1947. (BA22:8959.)

POTASSIUM CHLORATE
UNCITED REFERENCES

1. Huhtanen, I. Potassium chlorate - oil mixtures as explosives and their specific gas volumes, energy contents and explosion temperatures. Explosivstoffe 9: 189-94, 1960. (CA5:2105, 1961.) (Abstract only)

2. Plunkett, E. R. HANDBOOK OF INDUSTRIAL TOXICOLOGY. New York, Chemical Publishing Co., 1966, pp. 328-29.

3. Smith, Stanley. Action of potassium chlorate on concentrated sulfuric acid (Preliminary note). Proc. Chemical Soc. p. 124-25, 1910. (Abstract only)

4. Urbanski, Tadeusz. CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, Volume III. New York, Pergamon Press, 1967, pp. 274-80, 422.

POTASSIUM PERCHLORATE

Specific Approach. Potassium perchlorate, like potassium chlorate, is used in a variety of industries, the trades and medicine. Potassium hypochloride and peroidin were researched as synonyms, but since it yielded limited, botanical data, peroidin was deleted from the May update search strategy. Potassium perchlorate was also found in the CA categories, "alkali metal, perchlorates" and "alkali metal, hypochlorites," beginning with the DECENNIAL INDEX 1927-1936, in spite of its being referenced as an entity. Searching included CAS #7778-74-7, as well as the standard coordination of potassium and chlorates.

Chemistry. Potassium perchlorate, Peroidin, has a molecular weight of 138.6 and a molecular formula of $KClO_4$. The compound is in the form of colorless crystals or a white crystalline powder. One milligram of the material is soluble in 65 parts of cold water (i.e., 15,000 ppm) (1). Potassium perchlorate is used both as an oxygen donor in munitions and as an anti-thyroid drug.

POTASSIUM PERCHLORATE
BIBLIOGRAPHY

1. THE MERCK INDEX OF CHEMICALS AND DRUGS, AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS, PHYSICIANS, AND MEMBERS OF ALLIED PROFESSIONS. 7th ed. edited by Paul G. Stecher. Rahway, N. J., Merck & Co., Inc., 1960, p. 844.

2. Wyngaarden, J. B., Wright, B. N., and Ways, P. The effect of certain anions upon the accumulation and retention of iodide by the thyroid gland. Endocrindol. 50: 537, 1952.

3. Crooks, J., and Wayne, E. J. Comparison of potassium perchlorate, methylthionracil, and carbimazole in treatment of thyrotoxicosis. Lancet 1: 401, 1960.

4. Morgans, M. E. and Trotter, W. R. Treatment of thyrotoxicosis with potassium perchlorate. The Lancet 266: 749-51, 1954.

5. Moeschlin, Sven. POISONING DIAGNOSIS AND TREATMENT. First American Edition Translated by Jenifer Bickel from the Fourth German Edition. New York, Grune & Stratton, p. 216.

6. Trotter, W. R. The relative toxicity of antithyroid drugs. J. New Drugs 2: 333-43, 1962.

7. Morgans, M. E. & Trotter, W. R. Treatment of thyrotoxicosis with potassium perchlorate. (Letters to the Editor) Lancet 273: 1173, Dec., 1957.

8. Stanbury, John B. and Wyngaarden, James B. Effect of perchlorate on the human thyroid gland. Metabolism, Clin. & Exp. 1: 533-39, 1952.

9. DeGroot, Leslie J. and Buhler, Ulrich. Effect of perchlorate and methimazole on iodine metabolism. Acta Endocrinologica 68(4): 696-706, 1971.

10. Krevans, Julius R., Asser, Samuel P., Jr., and Kienhoff, William F. Fatal aplastic anemia following use of potassium perchlorate in thyrotoxicosis. J.A.M.A. 181: 162-64, 1962.

11. Rienhoff, William F., Jr. Fatal aplastic anemia and other complications following the so-called "antithyroid drugs" in treatment of thyrotoxicosis. Southern Med. J. 54: 1034-36, Sept. 1961.

12. O'Mahony, J. B. Oral lesions associated with potassium perchlorate and bone marrow depression. Br. Dent. J. 116: 168-9, Feb. 1964.

13. Milutinovic, Petar S., et. al. Thyroid function in a family with the Penred syndrome. J. Clin. Endocrinol. 29: 962-69, 1969.

14. Goldman, Stuart and Stanbury, John B. Metabolism of perchlorate in the rat. Endocrinology 92(5): 1536-38, 1973. (BA,31094, Sept. 15, 1973)

15. Haid, Herbert. (Effect of perchlorate, iodate and iodide on thyroid gland of Lacerta muralis laur.) Z. Mikrosk Anat. Forsch 83(3): 341-6, 1971. (Abstract only)

16. Hartmann, N., Vogler, H. & Vogler, C. (Effect of some thyroid inhibitors on peripheral turnover of thyroid hormones.) Acta Biol. Med. Ger. 26(3): 513-21, 1901. (Abstract only)

17. Gauss, Werner. (Behavior of some physiological and histological criteria of thyroid function in single or long administration of potassium perchlorate to adult mice. II. Short-term study.) Z. Mikrosk Anat. Forsch. (Leipz.) 86(1): 81-118, 1972. (Abstract only)

18. Goldobina, T. V. (Antithyroid activity of potassium perchlorate.) Eksptl. Issledovan. Fisiol. Biokkimii i Farmakol., Perm. Sbornik 1: 79-85, 1959. (CA55:47796) (Abstract only)

19. Maharevich-Gal'perin, L. M. and Ushenko, S. N. Comparative evaluation of the effect of 6-methylthiouracil and potassium perchlorate on the body. Patol. Fiziol. Eksptl. Terapiya 3(3): 63-7, 1959. (CA54:2572c) (Abstract only)

20. Selivanova, L. N. (Toxicological evaluation of ammonium perchlorate as an antithyroid preparation.) Farmikol. Toksikol. 32(3): 331-33, 1969. (Abstract only)

21. Nevelichuk, V. V. (Antiarrhythmic properties of antithyroid agents.) Farmakol. Toksikol 35(2): 185-88, 1972. (Abstract only)

22. Nevelichuk, V. V. (Effect of antithyroid drugs on the toxicity of isoproterenol.) Farmakol. Toksikol. 34(2): 170-73, 1971. (Abstract only)

UNCITED REFERENCES
POTASSIUM PERCHLORATE

1. Gleason, Marion N., Gosselin, Robert E., Hodge, Harold C., and Smith, Roger P. CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS ACUTE POISONING. 3d ed. Baltimore, Williams and Wilkens Co., 1969, p. 33.

2. Morgans, M. E. & Trotter, W. R. Treatment of thyrotoxicosis with potassium perchlorate. (Letters to the Editor), The Lancet 266: 883, 1954.

3. Perchlorate Explosives. Arms and Explosives 22: 145-46, 1914.

4. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2d ed. New York, Reinhold Publishing Co., 1963, p. 1128.

5. Urbanski, Tadeusz. CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, Volume III. New York, Pergamon Press, 1967, pp. 274-80, 422.

RED PHOSPHORUS

Specific Approach. Researching phosphorus was a relatively simple matter, as the literature is replete with information about phosphorus and its compounds. Yet at the time this research was conducted, there was no Chemical Abstracts registry number.

Throughout the literature on phosphorus, white and red, there is a recurring pitfall. Authors use the term "phosphorus" as a synonym for white or yellow phosphorus, thereby making the evaluation of the information somewhat more difficult. However, after in-depth analysis, it was possible to determine the authors' intent. In a few cases, authors discriminated generally between the forms of phosphorus; however, in the specific discussions on toxicity, they presented the toxicity of white phosphorus as though it applied to all forms, meanwhile claiming in foot-note fashion that the red allotrope is non-toxic.

Chemistry. Phosphorus exists in three allotropic forms: white (also called yellow), red, and black. White phosphorus is a colorless and waxlike solid that darkens and phosphoresces when exposed to light. In the presence of air, white phosphorus ignites spontaneously and burns with a blue flame producing a characteristically disagreeable odor that resembles garlic. Red phosphorus, a reddish-brown powder, is considerably more stable in air. In water, the white form is more stable than in air; whereas, the red form is considered insoluble, although no solubility data are actually available. No information could be obtained on the black allotrope.

RED PHOSPHORUS
BIBLIOGRAPHY

1. Moeschlin, Sven. POISONING DIAGNOSIS AND TREATMENT. First American Edition Translated by Jenifer Bickel from the Fourth German Edition. New York, Grune & Stratton, 1964, pp. 178-80.

2. von Oettingen, W. F. POISONING, A GUIDE TO CLINICAL DIAGNOSIS AND TREATMENT. 2d ed. Philadelphia, W. B. Saunders, Co., 1958, pp. 495-97.

3. Heimann, H. Phosphorus & its compounds, Red Phosphorus. Occupation & Health Vol. II: 1052, 1934.

4. Gleason, Marion N., Gosselin, Robert E., Hodge, Harold C., and Smith, Roger P., ed. CLINICAL TOXICOLOGY OF COMMERCIAL PRODUCTS, ACUTE POISONING. 3d ed. Baltimore, Williams & Wilkins, 1969, pp. 192-93.

5. Taylor's PRINCIPLES AND PRACTICE OF MEDICAL JURISPRUDENCE. 12th ed. edited by Keith Simpson. Boston, Little, Brown and Co., 19 , p. 341-45.

6. Goodman, Louis S. and Gilman, Alfred, editors. THE PHARMACOLOGICAL BASIS OF THERAPUTICS. 4th ed. New York, Macmillan Co., 1970, pp. 820.

7. Ferrannini, L. Phosphorus - Occupation & Health Vol II: 628, 1934.

8. Polson, C. J. and Tattersall, R. N. CLINICAL TOXICOLOGY, ("Circumstances of phosphorus poisoning.") Philadelphia, J. B. Lippincott Co., pp. 282-309.

9. Fleming, A. G. et. al. - MODERN OCCUPATIONAL MEDICINE 2d ed. 1960, pp. 518-19.

10. Heimann, H. Chronic phosphorus poisoning. J. Ind. Hyg. Toxicol. 28: 142, 1946.

11. Thayer, A. E. and Wolf, C. G. L. Toxicity of tetra-phosphorus trisulfid - a preliminary report. The J. of Med. Res. IX: 191-216, 1903.

12. Humphreys, Eleanor M. and Halpert, Beta. Acute phosphorus poisoning: Report of case due to ingestion of fireworks. Am. J. Dis. Child. 41: 354-59, 1931.

13. Phemister, D. B. Effect of phosphorus on growing, normal and diseased bones. J.A.M.A. 70(23):p. 1737-43, 1918.

14. Sollmann, Torald. Studies on chronic intorications of albino rats. VIII. Yellow phosphorus. J. Pharmacol. Exp. Ther. 24: pp. 119-22, 1925.

15. Ferrannini, L. Phosphorus - Occupation & Health Vol 11: 628, 1934.

16. Dalhamn, Tore. Animal experiments on spread of inhaled radioactive phosphorus in the body. AMA Archives of Indus. Health 20: 429, 1959.

17. Fleming, R. B. L., et. al. Some recent observations on phosphorus toxicology. J. Indus. Hyg. Toxicol. 24: 154, 1942.

18. Huruya, Atusi. Studies on the phosphorus intoxication of rabbits. J. Biochem. 10(1): 63-95, 1928.

19. Lawrence, John S. and Hoffman, M. M. Fatty changes in the Kupffer cells in the liver of the guinea pig in phosphorus poisoning. Arch. Path. 7: 809-12, 1929.

20. Williamson, Carl S. and Mann, Frank C. Studies on the physiology of the liver. V. Hepatic factor in chloroform and phosphorus poisoning. Am. J. Physiol. 65: 267, July 1923.

21. Best, C. H., McLean, D. L., and Ridout, Jessie H. Chlorine and liver fat in phosphorus poisoning. J. Physiol. 83(3): 275-84, 1935.

22. Mallory, Frank B. Phosphorus and alcoholic cirrhosis. Am. J. Path. 9: 557-67, 1933.

23. Barone, C., Cittandini, A., Caleota, T., and Terranova, T., Effect of intoxication induced in rat liver by carbon tetrachloride, ethionine and white phosphorus on level of microsomal cytochromes b-5 and P-450. Experientia 29: 73-4, May 1, 1973.

24. Okudaira, Nasahiko. Toxic hepatitis, especially on hepatic injuries caused by acute poisonings and chronic alcoholism in Medical examiner's cases. Acta. Path. Jap. 23(3): 629-37, 1973.

25. Adams, S. H., Davies, R. O., and Ashton, W. M. Phosphorus poisoning. Agric. J. Min. Agric. (Gt. Brit.) 49(1): 61-2, 1942.

26. Lawrence, John S. and Huffman, M. M. Increase in the number of monocytes in the blood following subcutaneous administration of yellow phosphorus in oil. Arch. Path. 7: 813-19, 1929.

27. Ferraro, A., Jervis, G. A., and English, W. H. P. Pathological changes in brain in cases of experimental phosphorus intoxication. Psychiat. Quart. 12: 294, 1938.

28. Ghoshal, Amiya K., Porta, Eduardo A., and Hartroft, W. Stanley. Isotopic studies on absorption and tissue distribution of white phosphorus in rats. Exp. Mol. Path. 14: 212-19, 1971.

29. Sollmann, Torald. Studies on chronic intoxications of albino rats. VIII. Yellow phosphorus. J. Pharmacol Exp. Ther. 24: 119-22, 1925.

30. Truhaut, R., et. al. - Etude des Modifications biochimiques provoquees par des intoxications aigues at subaigues au phosphores blanc chez le rat. (Biochemical Modification induced by acute and subacute poisoning with phosphorus in rat.) Annales pharmaceutiques francaises 30(1): 35, 1972.

31. Ghoshal, Amiya K., Porta, Eduardo A., and Hartroft, W. Stanley. Role of lipoperoxidation in pathogenesis of livers induced by phosphorus poisoning in rats. Am. J. Path. 54: 275-91, 1969.

RED PHOSPHORUS
UNCITED REFERENCES

1. Adams, Carrol O. Chemical Composition of transverse metaphyseal bands in growing bones by phosphorus ingestion. Proc. Soc. Exp. Biol. Med. 39(2): 351-54, 1938. (BA13:467, 1939)

2. Bueding, Ernest and Ladewig, Peter. Glucuronic acid produced by serving slices of liver from animals poisoned with phosphorus or chloroform. Proc. Soc. Exp. Biol. Med. 42(2): 464-65, 1939. (BA14:4373)

3. Carnes, William H., Pappenheimer, Alwin M., and Stoerk, Herbert C. Volume of parathyroid glands in relation to dietary calcium and phosphorus. Proc. Soc. Exp. Biol. Med. 51: 314-16, 1942.

4. Crane, C. W., Ebeling, P., and Bentely, A. B. Fatal case of acute phosphorus poisoning. Australasian Ann. Med. 8: 66-70, 1959.

5. Cressman, H. K., Richards, G. E., and Edwards, T. A. Preparation of and plant response to a yellow phosphorus-ammonia solution. Agronomy J. 62(6): 832-33, 1970.

6. Dodd, Percy V. Toxicological Memoranda: Case of phosphorus poisoning. Brit. Med. J. 2: 874, 1889.

7. Dwyer, Hugh L. and Helwig, Ferdinand C. Phosphorus poisoning in a child from the ingestion of fireworks. J.A.M.A. 84: 1254-56, 1925.

8. Hann, Reginald G. and Beale, L. A. Fatal case of poisoning by phosphorus with unusual subcutaneous hemorrhages. Lancet 1: 163-68, 1910.

9. Isom, Billy G. Stream pollution: toxicity of elemental phosphorus. Water Pol. Control Fed. 32: 1312-16, 1960.

10. Krishnan, S. S. and Gupta, R. C. Determination of phosphides and white phosphorus in biological materials by neutron activation analysis. Anal. Chem. 42(6): 557 May 1970.

11. LaDue, John S., Schenken, John R., and Kuker, Leo H. Phosphorus poisoning, a report of 16 cases with repeated liver biopsies in a recovered case. Am. J. Med. Sc. 208: 223-24, 1944.

12. Legge, Thomas M. Report of cases of phosphorus necrosis. J. Ind. Hyg. Toxicol. 22: 50-52, 1920/21.

13. Li, M. F., Traxler, G. S., and Langille, L. M. Toxic effects of elemental phosphorus on L-cells cultivated in suspension. Can. J. Zool. 48(1): 133-36, 1970.

14. McLean, Stafford, MacDonald, Aldred, and Sullivan, Ruth C. Acute phosphorus poisoning from the ingestion of roach paste. J.A.M.A. 93(23): 1789-92, 1929.

15. McIntosh, Rustin. Acute phosphorus poisoning: report of a case with recovery. Am. J. Dis. Child 34: 595-602, 1927.

16. Manley, Marion LeFevre and Ball, William F. Metabolism of inorganic phosphorus of rat bones and teeth as indicated by the radioactive isotope. J. Biol. Chem. 129(1): 125-34, 1939.

17. Pietras, Raymond J., et. al. - Phosphorus poisoning simulating white myocardial infarction. Arch. Intern. Med. 122: 430, Nov. 1968.

18. Pritchitt, H. D. Accidental phosphorus poisoning of a dog. Cornell Vet 29: 391-94, 1939.

19. Rothbaum, H. P. Red phosphorus as a possible fertilizer. Outlook On Agri. 5(3): 123-28, 1966.

20. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2d ed. New York, Reinhold Publishing Co., 1963, p. 1099.

21. Sontag, L. W. Phosphorus poisoning in infant resulting from antirachitic preparation. Am. J. Dis. Child 56: 114-18, 1938.

22. Walton, Duncan D. Treatment for white phosphorus burns. Chem. Warfare Bull. 28: 141, 1942.

23. Ward, Emma Francis. Phosphorus necrosis in manufacture of fireworks. J. Ind. Hyg. Toxicol. 10: 314, 1928.

24. Wells, G. Harlan. Report of a case of chronic phosphorus poisoning (phossy jaw). Med. Clin. of N. Amer. 10: 95-105, 1926.

25. Weissberger, Louise H. and Nasset, E. S. Phosphorus absorption in anesthetized dog as determined with the radioactive isotope. Am. J. Physiol. 138(1): 149-55, 1942.

26. Wertham, Frederic. Central nervous system in acute phosphorus poisoning. Arch. Neurol. & Psychiatr. 28: 320-30, 1932.

UNCITED REFERENCES
RED PHOSPHORUS

Abstracts Only:

1. Asakura, Kyumatsu & Satu, Tatsuo. Studies on the detoxicating hormone of the liver (Yakriton). 18th report. Prophylactic effect of yakriton against subacute phosphorus poisoning. Rabbit - Phosphorus-Unit (R.P.U.) of Yakriton. Tohoku J. Exp. Med. 14(2/3): 180-86, 1929. (BA6:729, 1932.)

2. Broussy, Jean. Remarques sur l'appareil agi de l'epithelium vesical du cobaze au cours d'une toxication phosphoree aigue. Arch. Soc. Sci. Med. Et. Biol., Montpellier, 11(3): 151-53, 1930. (BA7:17684, 1933.)

3. Caccuri, Scipione. (Alterations of celiac ganglion in experimental poisoning by phosphorus and by lead.) Riforma 45(35): 1168-70, 1929. (BA5:23530, 1931.)

4. Cuccione, F. (Reticulo-endothelial system intoxications of phosphorus, pulegone, and arsenic, in normal and splenectomized animals. Haematologica 10(1): 63-88, 1929.

5. Cunningham, R. S., Tompkins, E. H., and Lawrence, J. S. Formation of epithelioid, cells and giant cells in subcutaneous tissues following introduction of phosphorus in oil. Bull. Johns Hopkins Hosp. 46(5): 323-27, 1930. (BA5:20248, 1931.)

6. Erben, F. and von Hasselbach, H. Ein bei trag Zur Frage des Einflusses des Nervensystems auf die Verfettung der Leber bie phosphorbzw. Phloridzin vergiftung. Zeitschr. Ges. Exp. Med. 75(1/2): 145-66, 1931. (BA6:22161, 1932.)

7. Gubser, A. (Chemistry of fatty degeneration of the liver.) Biochem. Zeitschr. 198(1/3): 65-80, 1928.

8. Harant, Herve. Remarques sur la cytologie des cellules hepatiques au cours de necroses toxiques algues. Arch. Soc. Sci. Med. Et. Biol., Montpellier, 11(3): 146-49, 1930. (BA7: 17687, 1933.)

9. Hayashi, Inosuki and Arakawa, Shinya. Uber du Durchlassigkeit des Magendarmkanals fur artfremde Eiweisskorper bei Leberfunktionsstorung. Nagoya Jour. Med. Sci. 7(1): 1-26, 1933. (English summary.)

10. Lawrence, John S., Huffman, M. M. Fatty changes in Kupffer cells in liver in guinea pig in phosphorus poisoning. Arch. Path. 7(5): 809-12, 1929.

11. Mislowitzer, E. & Loewe, E. L. (Fatty degeneration of liver in phosphorus poisoning.) Biochem. Zeitschr. 216(4/6): 362-66, 1929. (BA5:17214, 1931.)

12. Mjassnikow, A. L. & Spamarin, G. A. (Origin of jaundice in increased erythrocytolysis.) Zeitschr. Ges. Exp. Med. 71(1/2): 40-48, 1930. (BA7:17296, 1931.)

13. Noah, G. (Blood lactic acid picture in normal rabbits and in rabbits with diseases of the liver.) Zeitschr. Ges. Exper. Med. 61(1/2): 59-62, 1928. (BA5:7842, 1931.)

14. Rosenfeld, Georg. (Pathology of fat production. I. Is fat formed from protein?) Biochem. Zeitschr. 209 (4/6): 312-18, 1929. (BA4:24175, 1930.)

15. Wakabayashi, Eiji. On the elimination of pigments in case of experimental disturbance of liver function. I. Functional disturbance caused by various kinds of pharmacological agents. J. Gastroenterol. 2(12): 1387 - 1406, (In Japanese). (BA7:10885, 1933)

16. Wertham, Frederic. Central nervous system in acute phosphorus poisoning. Arch. Neurol. and Psychiatr. 28(2): 320-30, 1932.

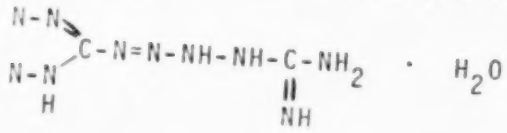
17. Yokota, T. Experimental investigation of hepatic function in pregnancy. I. Metabolism of carbohydrate. II. Hepatic amylase. Japanese J. Obstetr. and Gynecol. 14(2): 66-90; 91-105, 1931. (BA7:679, 1933.)

18. Zernik, F. (Percutaneous action of Phosphorus.) Zeitschr. Ges. Exp. Med. 70(1/2): 1-15, 1930. (BA5:7582, 1931.)

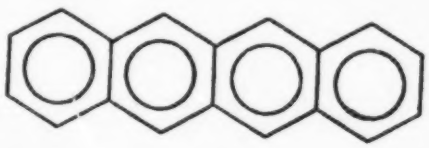
TETRAZENE

Specific Approach. The literature research for the primary explosive, tetrazene, was both confusing and difficult. According to Urbanski in CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, tetrazene is spelled with a "z" and is classified as a derivative of aminoguanidine. However, because of slight spelling variation, tetracene is sometimes mistaken for tetrazene. Tetracene is chemically completely different from tetrazene. Consequently, any citations concerning tetracene were inapplicable to tetrazene. The search strategy for tetrazene is outlined in Table 1, (in DNT section), but little information, other than chemical, was retrieved. Specific descriptors included tetrazene, tetracene and naphthacene(s). No CAS number was located for tetrazene.

Chemistry. Tetrazene (tetrazolylguanyltetrazene) is a light crystalline material that is colorless or pale yellow and practically insoluble in water (1). The compound is stable at temperatures below 75 degrees C, whether wet or dry, but hydrolyzes on being boiled in water. Tetrazene has a molecular weight of 188 and the following structure (2):



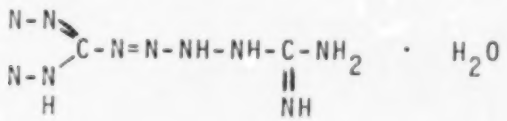
This compound should not be confused with the non-explosive "tetracene" whose structure (3) is



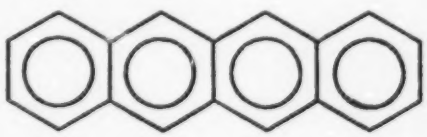
TETRAZENE

Specific Approach. The literature research for the primary explosive, tetrazene, was both confusing and difficult. According to Urbanski in CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, tetrazene is spelled with a "z" and is classified as a derivative of aminoguanidine. However, because of slight spelling variation, tetracene is sometimes mistaken for tetrazene. Tetracene is chemically completely different from tetrazene. Consequently, any citations concerning tetracene were inapplicable to tetrazene. The search strategy for tetrazene is outlined in Table 1, (in DNT section), but little information, other than chemical, was retrieved. Specific descriptors included tetrazene, tetracene and naphthacene(s). No CAS number was located for tetrazene.

Chemistry. Tetrazene (tetrazolylguanyltetrazene) is a light crystalline material that is colorless or pale yellow and practically insoluble in water (1). The compound is stable at temperatures below 75 degrees C, whether wet or dry, but hydrolyzes on being boiled in water. Tetrazene has a molecular weight of 188 and the following structure (2):



This compound should not be confused with the non-explosive "tetracene" whose structure (3) is



TETRAZENE
BIBLIOGRAPHY

1. Urbanski, Tadeusz. CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES, Vol. III. New York, Pergamon Press, 1967, pp. 206-9.

2. Patinkin, Seymour H., et. al. Structure of tetracene. A.C.S.J. 77: 562-67, 1955.

3. THE MERCK INDEX OF CHEMICALS AND DRUGS, AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS, PHYSICIANS, AND MEMBERS OF ALLIED PROFESSIONS. 7th ed. edited by Paul G. Stecher. Rahway, N. J., Merck & Co., Inc., 1960, p. 702.

UNCITED REFERENCES
TETRAZENE

1. Duke, J. R. C. X-Ray crystal and molecular structure of 'tetrazene' and 'tetracene' 1.) Chemical Communications p. 1-3, 1971, Com. 1706. 2.) AD737 257, but not available from NTIS.

2. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2d ed. New York, Reinhold Publishing Co., 1963, p. 1240, 1033-34, 1225.

TITANIUM

Specific Approach. The procedure followed to research the literature of titanium was relatively uncomplicated. Browning's TOXICITY OF INDUSTRIAL METALS provided the best overview of the subject in capsular form. Based on Browning's treatment, both titanium oxide and titanium were included in the computer strategy, as well as titanium dioxide, but did not include a Chemical Abstracts registry number. Kirk-Othmer states that titanium was discovered in the late 1700's and that it did not become commercially important until after World War II. Our research bears that out also. In fact, the bulk of the material retrieved fell into the late 1930's and early 1940's, then showed a lagging interest during the late 1950's and 1960's with renewed investigation during the 1970's.

Chemistry. Titanium, the 22nd element of the periodic table, has an atomic weights of 47.9. This element has valences of 2, 3, or 4, but most commonly is trivalent. As a metal, titanium is dark-grey and lustrous and forms alloys with copper and iron, with steel and with aluminum. It is frequently found in nature as the minerals of titanium dioxide (TiO_2) (1). The compounds most often found in industry are the dusts of TiO_2 and $TiCl_4$.

Titanium's main uses appear to be as a component of skeletal prostheses, in alloys, as a mordant in the dye industry, as a pigment in the paint industry, in aircraft and missiles.

TITANIUM
BIBLIOGRAPHY

1. THE MERCK INDEX OF CHEMICALS AND DRUGS AN ENCYCLOPEDIA FOR CHEMISTS, PHARMACISTS, PHYSICIANS, AND MEMBERS OF ALLIED PROFESSIONS. 7th ed. edited by Paul G. Stecher. Rahway, N. J., Merck & Co., Inc., 1960.

2. Stokinger, H. E. "Titanium, Physiological Response." In: INDUSTRIAL HYGIENE AND TOXICOLOGY. 2d rev. ed. Volume II, Toxicology. Frank A. Patty, editor. New York, Interscience, 1962, pp. 1157-58.

3. Browning, Ethyl. TOXICITY OF INDUSTRIAL METALS, 2d ed., New York, Appleton-Century-Crofts, 1969, pp. 331-35.

4. Vernetti-Blina, L. Ricerche clinica e sperinentole sull'Assido di Titanio. Riform. Med. 47: 1516, 1928.

5. Lehmann, K. B. and Zerget, L. Hygienic manufacture of titanium dioxide and titanium white. Chem. Ztg. 82: 795, 1927.

6. Christie, Helen, McKay, R. J. and Fisher, A. M. Pulmonary effects of inhalation of titanium dioxide by rats. Am. Ind. Hyg. Assoc. J. 24(1): 42-46, 1963.

7. Lenzi, L. La pneumoconiosi des Titanweiss. Rass. Med. Indus. 7: 301, 1936.

8. Schroeder, Henry A., Ballassa, Joseph J., and Tipton, Isabel H. Abnormal trace metals in man: titanium. J. Chron. Dis. 16: 55-69, 1963.

9. Schroeder, Henry A., Vinton, William H., Jr. and Balassa, Joseph J. Effect of chromium, cadmium and other trace metals on growth and survival of mice. J. Nutrition 80: 39-47, 1963.

10. Schroeder, Henry A. and Mitchner, Marian. Toxic effects of trace elements on reproduction of mice and rats. Arch. Environ. Health 23(2): 102-06, 1971.

11. Beder, D. E. and Eade, G. Tissue tolerance to titanium metal implants in dogs. Surgery 39: 470, 1956.

12. Beder, D. E., Stevenson, J. K., and Jones, T. W. Further investigations of the surgical application of titanium metal in dogs. Surgery 41: 1012, 1941.

13. Gross, P. P. and Gold, L. Compatibility of vitallium and austenium in completely buried implants in dogs. Oral Surg. 10: 769, 1957.

14. Hille, Guenther H. Titanium for surgical implants. J. of Mater. 1: 373-83, 1966.

15. Galante, Jorge and Rostoker, William. Fiber metal J. Biomed. Mater. Res. Symposium No. 4: 43-61, 1973.

16. Rhinelander, Frederic W., Rouweyha, Marwan, and Milner, John C. Microvascular and histogenic responses to implantation of a porous ceramic into bone. J. Biomed. Mater. Res. 5: 81-112, 1971.

17. Predecki, Paul, Stephan, J. F., Auslaender, B. A., Mooney, Vert L. and Kirkland, K. Kinetics of bone growth into cylindrical channels in aluminum oxide and titanium. J. Biomed. Mater. Res. 6: 375-400, 1972.

18. Breaux, L. P. Clinical observations on use of titanium salts in use of treatment of dermatitis. Can. Med. Assn. J. 73: 47, 1955.

19. Lloyd, L. E., Rutherford, B. Blaine, and Crampton, E. W. Comparison of titanium, oxide and chromic oxide as index materials for determining apparent digestibility. J. Nutr. 56(2): 265-71, 1965.

20. Ishikawa, Shikao. Comparison of the rates of passage of chromic oxide, titanium dioxide and ferric oxide used as indicators through the digestive tract. Agric. Biol. Chem. 26(6): A38, 1962.

21. Maillard, L. C. and Ettori, J. Titanium in mammalian tissue and especially those of man. Compt. Rend. Soc. Biol. 122: 951, 1936.

22. Pauley, Gordon B. and Ivy, A. C. Prevention of flash burns by protective glove film. U. S. Naval Med. Bull 43(2): 209-15, 1944.

23. Kato, L. and Gozsy, B. Stimulation of cell-linked defense forces of the skin, mechanism of action of certain topical agents. Can Med. Assn. J. 73: 31-34, 1955.

24. Giese, Arthur C. and Wells, Julian M. Sweat and water-resistant sunburn preparations. J. Amer. Pharmaceutical Assn., Sci. Ed., 35(7): 208-11, 1947.

25. Skin Hazards in American Industry, Part III. Public Health Bulletin No. 249. Washington, D. C., G.P.O., 1939, p. 55.

26. Macleod, T. M., and Frain-Bell, W. Study of efficiency of some agents used for protection of skin from exposure to light. Br. J. Derm. 84: 266-81, 1971.

27. Titanium. Hygienic Guide Series. Amer. Indus. Hyg. Assn. J. 34(6): 275-77, 1973.

28. Dale, Knut. Early effects of quartz and titanium dioxide dust on pulmonary function and tissue. Scand. J. Resp. Dis. 54: 168-84, 1973.

29. Ferin, J. Lung clearance of titanium dioxide particles in rats. Presented at 9th Annual Meeting of American Society of Toxicology, 1970.

30. Elo, Risto, Maata, Kari, Uksila, Erkki, Arstilla, Antti N. Pulmonary deposits of titanium dioxide in man. Arch. Path. 94: 417-24, Nov. 1972.

31. Bernheim, Frederick and Bernheim, Mary L. C. Effect of titanium on oxidation of sulfhydryl groups of various tissues. J. Biol. Chem. 127(3): 695-703, 1939.

32. Gould, Bernard S. Effects of thorium, zirconium, titanium and cirium on enzyme action. Proc. Soc. Exp. Biol. Med. 34: 381-85, 1936. (BA11:18343.)

33. Cavanaugh, D. J., Harris, Joseph, and Hearon, J. Z. Enzyme inhibition by complexing of substances: inhibition of tyrosinase by titanium compounds. J. Am. Chem. Soc. 77:1531-35, 1955.

34. Heaton, Noel. Titanium oxide pigments. Chem. Trade J. & Chem. Engineer 85: 439, 1929.

TITANIUM
UNCITED REFERENCES

1. Clarke, E. G. C. and Hickman, J. Investigation into the correlation between the electrical potential of metals and their behavior in biological fluids. J. Bone Joint Surg. 35B(3): 467-73, 1953.

2. McCue, John P. Titanium analysis of human blood. Biochem. Anal. 7: 282-87, 1973.

3. Plunkett, E. R. "Titanium Tetrachloride." In: HANDBOOK OF INDUSTRIAL TOXICOLOGY. New York, Chemical Publishing Co., 1966, 391-92.

4. Sax, N. Irving, ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2d ed. New York, Reinhold Publishing Co., 1963, p. 1254.

1. Ballotta, Francesco. (Action of titanium on the body.) Med. Lavoro 22(4): 158-64, 1931. (BA9:3007, 1935) (Abstract only)

2. Fournier, P. (Utilization of titanium oxide in quantitative study of intestinal absorption.) Compt. Rend. Acad. Sci. (Paris) 231(23): 1343-45, 1950. (BA26:14805, 1952.) (Abstract only)

3. Mauri, Eitaro. (Pharmacological action of Ti, ZR, and TH.) Folia Pharmacol. Japonica. 8(1):20-35, 1928. (BA4:27752, 1930.) (Abstract only)

MUNITIONS
GENERAL

1. Furchgott, Robert F. Pharmacology of vascular smooth muscle. IV. Nitrates, organic nitrates and azide. PHARMACOLOGICAL REVIEWS, Volume 5. Baltimore, 1955, pp. 210-11.

2. Skin hazards in American industry, Part III. Public Health Bulletin No. 249. Federal Security Agency, U. S. Public Health Service, Washington, D. C., G.P.O., pp. 80-93.

3. Graham, Stanley G. and Tisdell, Frederick F. Poisoning from external use of resorcin. Can. Med. Assn. J. 12: 730-32, 1922.

4. Modell, Walter. Clinical pharmacology of antianginal drugs. Clin. Pharmacol. Ther. 3: 97-108, 1962.

5. Winsor, Travis, Kaye, Harry, and Mills, Barbara. Hemodynamic response of oral long-lasting nitrates: evidence of gastroinstestinal absorption. Chest 62(4): 407-13, Oct. 1972.

6. Winburg, Martin M., Howe, Burton B., and Hefner, Mildred A. Effect of nitrates and other coronary dilators on large and small coronary vessels: an hypothesis for mechanism of action of nitrates. J. Pharmacol. Exp. Ther. 168(1): 70-95, 1969.

7. Commarato, Michael A., Winburg, Martin M. and Kaplan, Harvey B. Glyceryl trinitrate and pentaerythritol (pentaerythritol trinitrate): Comparative cardiovascular effects in dog, cat and rat by different routes of administration. J. Pharmacol. Exp. Ther. 187(2): 306-07, 1973.

8. Shils, Maurice E. and Goldwater, Leonard J. Nutritional factors affecting toxicity of some aromatic hydrocarbons with special reference to benzene and nitrobenzene compounds: a review. J. Indus. Hyg. & Toxicol. 31(4): 175-83, July 1949.

9. Tollman, J. P., MacQuiddy, E. L., and Schonberger, Stanley. Inhalation of filtered carbon arc fumes and oxides of nitrogen. J. Indus. Hyg. & Toxicol. 23(6): 269-75, June 1941.

10. Whitworth, Edward. Explosives. Repts. Soc. Chem. Ind. on Progr. Appl. Chem. 41: 221-38, 1956.

11. Shot, Shell, and Bombs: a $3-billion ammunition industry, built in three years, tripled its rated capacity to give U. S. Soldiers overwhelming fire power. Fortune 32: 131-36, 260, 262, 265-66, Sept. 1945.

12. Levy, S. I. Modern explosives - I. School Sci. Rev. 17: 341-49, 1936.

13. Harrell, George T. Chemical warfare in civilian defense N. Carolina Med. J. 4: 4-6, Jan. 1943.

14. Rice, James C. Industrial toxicology as related to the war effort. Tri-State Med. J. 15: 2827-30, Nov. 1942.

15. Batty, W. E. Explosives. Repts. Progr. Appl. Chem. 43: 142-58, 1958.

16. Marshall, C. R. Mode of action of nitric esters. J. Pharmacol. Exp. Ther. 83: 106-19, 1945.

17. Carlisle, J. M. Pulmonary edema. J.A.M.A. 123(15): 947-48, Dec. 1943.

18. von Oettingen, W. J. Organic chemical industrial hazards to health. Physiol. Rev. 22: 170-89, 1942.

19. Hudson, W. G. Explosives industry poisons. Medical Record 91(3): 90-98, Jan. 20, 1917.

20. Peck, Samuel M., Gants, James Q., Jr., and Scwartz, Louis. "Hardening" in industrial allergic dermatitis. Indus. Med. 14: 214-22, March 1945.

21. Clark, D. G. and Litchfield, M. H. Toxicity, metabolism and pharmacologic properties of propylene glycol 1, 2,-dinitrate. Toxicol. Appl. Pharmacol. 15: 175, 1969.

22. Cohen, Julius S. Berend and McCandlish, Douglas. Mechanism of hydrogen sulfide reduction of nitro-compounds. J. Chem. Soc. 87: 1257, 1905.

23. DiCarlo, Frederick, Crew, Malcolm C., Haynes, Lloyd J., and Wilson, Margaret. Pentarythritol trinitrate metabolism by the rat. Biochem. Pharmacol. 18: 1985, 1969.

24. Gibson, William Howieson, Duckham, Rebecca, and Fairbairn, G. Products of nitration of toluene. J. Chem. Soc. 121: 270, 1922.

25. Kratz, John C., Jr., Carr, C. Jelleff, and Forman, Sylvan E. Pharmacology of high molecular weight alkyl nitrites. Proc. Soc. Exp. Biol. Med 42: 472-74, 1939.

26. Page, Harold James and Heasman, Benjamin Richard. Preparation of 2,3-, 2,5-, and 3,4-dinitrotoluene. J. Am. Chem. Soc. 123: 3235, 1923.

27. Patty, Frank A. Aliphatic nitrates. Indus. Hyg. & Toxicol.: 2085, 1963.

28. Turekian, Karl K. and Kulp, J. Laurence. Strontium content of human bones. Science 124: 405, 1956.

29. Prerpvska, I. and Teisinger, J. Clinical picture of chronic intoxication with dinitro diglycol. Pracovni Lekar. 17: 41-43, 1965.

30. Yagoda, Herman and Goldman, F. H. Analysis of atmospheric contaminants containing nitrate groupings. J. Indus. Hyg. Toxicol. 25: 440, 1943.

31. Schaffner, Fenton. Iatrogenic jaundice. J.A.M.A. 174(13): 96-101, 1960.

32. Ogawa, K. and Gudbjarnasson, S. A correlation between the inhibition of monoamine oxidase organic nitrates. Arch. Int. Pharmacodyn. 172(1): 172-82, 1968.

33. Schwartz, Louis. Occupational dermatoses in war industries. Proc. 7th Annual Meeting Industrial Hygiene Foundation, Inc., 1943, pp. 36-47.

34. Hueper, W. C. and Landsberg, J. W. Experimental studies in cardiovascular pathology. I. Pathologic changes in organs of rats produced by chronic nitrite poisoning. Arch. Path. 29: 633-48, 1940.

35. Needleman, Philip, Lang, Stanley, and Johnson, Eugene M., Jr. Organic nitrates: relationship between biotransformation and rational angina pectoris therapy. J. Pharmacol. Exp. Ther 181(3): 489-97, 1972.

36. Ballard, W. E. Some environmental problems of metal spraying processes. Ann. Occup. Hyg. 15: 101-06, 1972.

37. Rice, James C. Toxicology in relation to war industries. The Merck Report 53(2): 28-30, 1944.

38. Needleman, Philip and Hunter, F. Edmund, Jr. Transformation of glyceryl trinitrate and other nitrates by glutathione-organic nitrate reductase. Mol. Pharmacol. 1: 77-86, 1965.

39. Popper, Hans and Schaffner, Fenton. Drug-induced hepatic injury. Ann. Int. Med. 51: 1230-52, 1959.

40. Downing, John Godwin. The skin and industry. Indus. Med. 1(1): 19-20, 1932.

41. Overton, Sibyl. Industrial dermatoses: their causation, recognition, prevention and treatment. Br. J. Dermat. & Syph. 51: 255-64, 1929.

42. Downing, John Godwin. Cutaneous eruptions among industrial workers: review of two thousand claims for compensation. Arch. Dermat. & Syph 39: 12-32, 1939.

43. Buller, Robert H. and Carr, C. Jelleff. Vasodepressor activity of a new organic nitrate and a contribution to the mechanism of action of this class of drugs. Arch. Int. Pharmacodyn. 123: 452-61, 1960.

44. Horner, Sibyl G. Some observations on industrial dermatitis. The Lancet 2: 233-36, 1934.

45. Weeks, Maurice H. and Tevich, Paul. Toxicity of combustion products of pyrotechnics. Amer. Ind. Hyg. Assn. J. 24: 622-29, 1963.

MUNITIONS
Secondary References

1. Allen, Shannon. Ability of human subjects to withstand "explosive compression." Fed. Proc. 6(1): 68, 1947.

2. Batty, W. E. Explosives. Rept. Prog. Appl. Chem. 47: 135, 1969.

3. Blum, S. W., Quinn, J. B., and Dubnick, B. Effects of petrin and other organic nitrates on rat heart mitochondrial activities. Warner-Lambert Research Institute. Morris Plains, J. S. 07950. (abstract only)

4. Bowditch, Manfred, Drinker, C. K., Drinker, Philip, Haggard, H. H., and Hamilton, Alice. Code for safe concentration of certain common toxic substances used in industry. J. Ind. Hyg. Toxicol. 22: 251, 1940.

5. Brandimarte, Enzo. La detonazione. Revista Aeronautticci 75-77, 1971.

6. Brandt, Allen D. Industrial hygiene engineering in the Army explosives manufacturing and processing industry. Indus. Med. 13: 639, 1944.

7. Brinkley, Ruth F. and VanDolah, R. W. Research and technologic work on explosives, explosions and flames, fiscal years 1957 and 1958. U. S. Bureau of Mines Information Circular 7999, 1961.

8. Bryan, A. M. Unusual occurrences of inflammable and noxious gases in mines. The Colliery Guardian 144: 204, 1932.

9. Broom, W. A. The toxicity and glycaemic properties of a number of amidine and guanidine derivatives. J. Pharmacol. Exp. Ther. 57(1): 81, 1936.

10. Carmichael, Peter and Lieber, Jan. Sudden death in explosive workers. Arch. Environ. Health 7(4): 424, 1963.

11. Chow, S. Y., Chang, L. R., and Yen, M. S. A comparison between the uptakes of radioactive perchlorate and iodide by rat and guinea pig thyroid glands. J. Endocr. 45: 1, 1969.

12. Clark, D. G. and Litchfield, M. H. Toxicity, metabolism and pharmacologic properties of propylene glycol 1,2-dinitrate. Toxicol. Appl. Pharmacol. 15: 175, 1969.

13. Cohen, Julius Berend and McCandlish, Douglas. The mechanism of the hydrogen sulfide reduction of nitro compounds. J. Chem. Soc. 87: 1257, 1905.

14. Cook, James A. Maximum allowable concentrations of industrial atmospheric contaminants. Indus. Med. 14: 936, 1945.

15. Crandall, L. A., Jr., Leake, C. D., Lovenhard, A. S., and Muehlberger, S. W. Acquired tolerance to and cross tolerance between the nitrous and nitric esters and sodium nitrite in man. J. Pharmacol. Exp. Ther. 41: 103, 1931.

16. DiCarlo, Frederick J., Crew, Malcolm C., Haynes, Lloyd J., and Wilson, Margaret. Pentaerythritol trinitrate metabolism by the rat. Biochem. Pharmacol. 18: 1985, 1969.

17. Desvergnes, Louis. 1,3,5-trinitrobenzene or benzene. Chimie et Industrie 25(1): 3-17, 291-306, 1931.

18. Desvergnes, Louis. Pentaerythritol tetranitrate or penthrit. Chime et Industrie 29: 1263, 1933.

19. Evans, E. E., Charshrand, R. C., and Lynch, A. L. Evaluation of chemical cyanosis through improved techniques for hemoglobin analysis. A.M.A. Archives of Indus. Health 18:422, Nov. 1958.

20. Fawcett, H. H. Exposures of personnel to laboratory hazards. Amer. Ind. Hyg. Assoc. J. 33(8): 559, 1972.

21. Finlayson, J. S. and Baumann, C. A. Responses of rats to urea and related substances. J. Nutr. 59(2): 211, 1956.

22. Foulger, John H. Physiologic effects of certain explosives and chlorinated hydrocarbon solvents. U. S. Armed Forces Med. J. 4: 1425, 1953.

23. Foulon, A. Verschiedene Neurungen im sprengstoffgebeit. Nitrocellulose 6: 99, June 1933.

24. Gafafer, W. M. OCCUPATIONAL DISEASES, A GUIDE TO THEIR RECOGNITION. Washington, D. C., G.P.O., 1964.

25. Golden, Alfred and Silverglade, Alexander. Sensitization of guinea pigs to cyclic compounds and effect on hematopoietic system. Proc. Soc. Exp. Biol. Med. 37: 400, 1937.

26. Howe, H. E. Science in the new competition. Proc. 26th Fuel Eng. Confr., Washington, D. C. June 21, 1940., pp. 109-13.

27. Hueper, W. C. and Lansberg, J. W. Experimental studies in cardiovascular pathology. Arch. Pathol. 29: 633, 1941.

28. Hueper, W. C. and Ichniowski, C. T. Toxicopathologic studies on s-methylisothiourea. Arch. Path. 37: 253, 1944.

29. Hyatt, E. C. and Milligan, M. F. Experiences with unusual materials and operations. Am. Ind. Hyg. Assoc. Quart. 14: 289, 1953.

30. Insausti, Thomas. Repercusidn clinica de las intoxicaciones del sistema nervioso central y periferico. La Prensa Medica Argentine 57(21): 999, 1970.

31. Kaplan, Abram S., Berhout, Christian F. and Peczenik, Alois. Human intoxication from RDX. Arch. Environ. Health 10: 877, 1965.

32. Keil, Harry. Group reactions in contact dermatitis due to resorcinol. Arch. Dermatol. 86: 212, Aug. 1962.

33. Klauder, Joseph V., Gross, Elmer R., and Brown, Herman. Prevention of industrial dermatitis with reference to protective hand creams. Arch. Dermat & Syph. 41: 331, 1940.

34. Konrad, Joseph V. Neuerugen aus der sprengstoffindustrie im Jahre 1932. Nitrocellulose 4: 37, 1933.

35. Konrad, Joseph V. Neuerungen aus der sprengstoffindustrie im Jahre 1933. Nitrocellulose 5: 62, 1934.

36. Konrad, Joseph V. Neuerungen aus der sprengstoffindustrie im Jahre 1935. Nitrocellulose 6: 101, 1936.

37. Landsteiner, Karl, Rostenberg, Adolph, Jr., and Sulzberger, Marion B. Individual differences in susceptibility to ecezmatous sensitization with simple chemical substances. J. Investigat. Dermatol. 2: 23, 1938.

38. Landsteiner, K. and Jacobs, John. Supplementary note on skin sensitization with simple chemical compounds. Proc. Soc. Exp. Biol. Med. 31: 1078, 1934.

39. Maçek, Andrej. Sensitivity of explosives. Atlantic Research Corporation, Alexandria, Va., 1961.

40. Machle, Willard, Scott, E. W., and Trian, Joseph. Physiological response of animals to some simple mononitroparaffins and to certain derivaties of these compounds. J. Ind. Hyg. Toxicol. 22: 315, 1940.

41. Malkinson, Frederick D. Percutaneous absorption of toxic substances in industry. A.M.A. Arch. Ind. Health 21: 87, 1960.

42. Mitchell, James H. Resorcin anal dermatitis due to resorcin in anusol suppositories. J.A.M.A. 101: 1067, 1933.

43. Mohlman, F. W. Industrial wastes in wartime. Sewage Works J. 15(6): 1064, 1943.

44. Morikawa, Yukio. Organic nitrate poisoning at an explosive factory: plethysmorgraphic study. Arch. Environ. Health 14(4): 614, 1967.

45. Mudri, S. S., Godbole, S. H., and Parabrahmam, M. Characteristics of wastes from an explosive factory and effects of the wastes on river water. Environ. Health 9: 220, 1967. (BA51:5114.)

46. Needleman, N., Blehm, D. J., and Totskoff, K. S. Relationship between glutathione-dependent denitration and the vasodilator effectiveness of organic nitrates. J. Pharm. Exp. Toxicol. 165(2): 286, 1969.

47. Oster, Kurt A. Predisposition to atherosclerosis. (Letters to Editor.) J.A.M.A. 222(6): 704, Nov. 1972.

48. Patterson, H. M. Weil's Disease. Hawaii Med. J. 3: 213, 1944.

49. Perrott, G. St. J., Babcock, L. W., Bitting, C. D., and Jones, G. W. Toxic gases from 60 per cent gelatin explosives. U. S. Department of Commerce, Bureau of Mines Technical Paper 482. Washington, D. C., Government Printing Office, 1930.

50. Phipps, Frederick C. Influence of the thyroid on the acute toxicity of a dynamite sensitizing mixture (36135). Proc. Soc. Exp. Biol. Med. 139(1): 323, 1972.

51. Pinto, Sherman S. and Bowditch, Manfred. Medical progress: industrial hygiene. New Eng. J. Med. 255(24): 949, 1941.

52. Platonow, N. and Coldwell, B. B. Metabolism of ethanol in cold environment. I. Effect of alcohol pretreatment. II. Effect of dose on rat. III. Effect of phenoxybenzamine and potassium perchlorate. Quart. J. Stud. Alc. 29(1A): 1, 1968.

53. Plitman, S. I. Experimental validation of the maximum permissible concentrations of pentaerythritol and xylitol in water bodies. Hygiene & Sanitation (from Russian journal, Gig. i. Sanit.) incomplete citation

54. Prentiss, Austin M. and Fisher, George B. CHEMICALS IN WAR - A TREATISE ON CHEMICAL WARFARE. New York, McGraw-Hill, 1937.

55. Sax, Irving N., ed. DANGEROUS PROPERTIES OF INDUSTRIAL MATERIALS, 2d ed. New York, Reinhold Publishing Company, 1963. Explosives, high, low. pp. 826-832.

56. Schonfeld, W. Ekzematose uberempfindlichkeitser scheinungen bei Angehorigen arztlicher Berufe. (Eczema due to hypersensitivity in medical profession.) Die Medizinische Welt. 6: 1055, 1932.

57. Scott, James L., Cartwright, George E., and Wintrobe, Maxwell M. Acquired aplastic anemia: an analysis of thirty-six cases and review of pertinent literature. Medicine 38: 119, 1959.

58. Schwartz, Louis. Occupational dermatoses in war industries. Proc. 7th Ann. Meeting, Am. Ind. Hyg. Foundation, p. 36, 1942. (published 1943.)

59. Sedgwick, Frank H. Industrial dermatitis. 2. Character, incidence, and treatment. Soap, Perfumery & Cosmetics 15: 419, 1942.

60. Sisenwine, Samuel F. and Ruelius, Hans W. Plasma concentrations and urinary excretion of isosorbide dinitrate and its metabolites in the dog. J. Pharmacol. Exp. Toxicol. 176(2): 296-301, 1971.

61. Sequeira, J. H. Dermatitis due to high explosives: four cases of dermatitis due to high explosives used in recent air raids. Proc. Roy. Soc. Med., London Soc. Dermal. 12, 1917-18. (Just an announcement.) (Fuller description Br. Med. J. 148: Aug. 4, 1917.)

62. Sillcox, L. K. Fuels of the future (Lecture delivered at Annual Meeting of The Franklin Institute, January 19, 1955). J. Franklin Inst. 259: 183, March 1955.

63. Stirpe, Dante, Johnson, James O., and Wackerle, Jerry. Shock initiation of XTX-8003 and pressed PETN. J. Appl. Phys. 41(9): 3884, 1970.

64. Stone, William J., Paletta, Theodore L., Heiman, Elliott M., Bruce, John I., and Knepshield, James H. Toxic effects following ingestion of C-4 plastic explosive. Arch. Intern. Med. 124: 726, 1969.

65. Stokinger, Herbert. Threshold Limit Values for 1963. J. Occup. Med 5(10): 491, 1963.

66. Tabershaw, Irving R. Medical Progress: industrial hygiene. N. Eng. J. Med. 233(15): 437, 1945.

67. Tulis, Allen J. and Hersh, Charles K. Decoupling of physical and chemical mechanisms in explosive reactions. Astronautica Acta 17: 435, 1972.

68. Wood, John R. Chemical warfare - a chemical and toxicological review. Am. J. Pub. Health 34: 455-60, 1944.

69. Wyatt, R. M. H. Ignition of primary explosives by electric discharges. Proc. Roy. Soc. (London) A246: 189-96, 1958.

70. Yang, L. C. and Menichelli, Vincent J. Detonation of insensitive high explosives by a Q-switched ruby laser. Appl. Phy. Let. 19(11): 413, Dec. 1971.

71. Zabransky, Frank W. and Wright, Harold N. Preliminary investigation of fungistatic properties and toxicity of certain resorcinol derivatives. J. Amer. Pharm. Assoc., Sci. Ed. 46(3): 185, 1957.

72. Zaehringer, Alfred J. Solid propellant bibligraphy. Jet Prop. 27: 300-27, 1957.

MUNITIONS
MISCELLANEOUS DOCUMENTS

1. Duncan, A. A. Effects of various environmental conditions of recrystallized PETN. U. S. Atomic Energy Commission, Albuquerque Operations Office, Albuquerque, New Mexico, April 1972. (U. S. Government Contract DA-11-173-AMC-487 (A)). Studies covered: "elevated temperature (ambient to 125 C), sample confinement (closed & open containers), elevated and reduced pressure (0.03 to 6700 mm Hg),... solvent reactions... and weight loss as a function of temperature and pressure, as well as a general theoretical approach to crystalline change."

2. AD-752-700 Pyrotechnics, A DDC Bibliography. DDC-TAS-72-66, November 1972. (DDC) "Collection of unclassified references to unclassified reports on pyrotechnics... pertaining to composition, safety, design configuration, launching, binders, release mechanisms, performance and capability."

3. AD-474-401 Investigation of hazards in the processing of pyrotechnic mixtures for chemical agent munitions. Final report, July - December 1964. U. S. Army Chemical Research and Development Laboratories, Edgewood Arsenal, Md., March 1965. (DDC) Investigation includes specific tests as: "Impact sensitivity, vacuum thermal stability, auto-ignition temperature, differential thermal analysis, effects of impurities, variation in composition of formulations, smoke mixtures with sulfur or lactose and effect of additives for improved blending."

4. AD-605-706 Andreyev, K. K., et. al. Translation, Theory of explosives. Foreign Technology Division, Wright-Patterson Air Force Base, Ohio. January 31, 1964. (CFSTI) (FTD-MT-63-254). Translation of Russian text sub-divided into 4 parts: "sensitivity of explosives to mechanical influences;... thermal disintegration of... nitrocompounds;" ignition and detonation of explosives;... theory of explosives.

5. N72-18969 Pyrotechnic hazards classification and evaluation program. Phase II, Segment 3: Test plan for determining hazards associated with pyrotechnic manufacturing processes. General Electric, Bay Saint Louis, Mississippi. January 29, 1971. (NTIS).

6. AD-726-503 Jenkins, J. M. (editor). Explosives research and development establishment. Proceedings of Symposium on Sensitiveness and Safety of Initiators. April 17-June 25, 1969. Waltham Abbey, Essex, England. (ERDE WAA/196/015) (DDC) Discussion of "manufacture and handling... and loading of... primaries or initiators"... which excludes "hazards of filled stores."

7. N72-18963 Pyrotechnic hazards classification and evaluation program. Electrostatic vulnerability of the E8 and XM15/XM165 clusters. Phase I. Final report. December 31, 1970. Prepared by General Electric Co. for NASA, George C. Marshall Space-flight Center, Mississippi Test Facility (GE-MTSD-F-052) (NTIS). Report covers: description of "electrostatic theory as it applies to system vulnerability", evaluation of "XM15/XM165 and E8 material characteristics"; determination of conditions affecting "electrostatic initiation sensitivity"; construction of "electrical circuits to facilitate analysis and interpretation of data"; and development of "Phase II test plan."

8. N72-18965 Pyrotechnic hazards classification and evaluation program. Phase III, Segments 1-4: Investigation of sensitivity test methods and procedures for pyrotechnic hazards evaluation and classification. Part A. April 19, 1971. Prepared by General Electric Co., for NASA, George C. Marshall Spaceflight Center, Mississippi Test Facility. (GE-MTSD-R-059.) (NTIS) Report covers "fundamentals of proposed new method of classifying pyrotechnics" and includes "identi-fication of information needed to satisfy new classification criteria... of currently accepted tests which provide some of this information; recommended modifications to current test/ classification devices... recommendations for test to develop new methods to fit proposed classification criteria."

9. AD-737 500 Environmental pollution: sanitary engineering and industrial wastes. A DDC Bibliography January 1963 - May 1971 (DDC-TAS-71-57-1). February 1972. (DDC) Compilation of references of unclassified reports dealing with... sanitary engineering and industrial waste...refer to documents processed into the "AD" data bank from January 1963 - September 1971.

10. JPRS-50025 Yaremenko, N. Ye, et. al. (USSR) Properties and preparation of explosives. Joint Publication Research Service, Washington, D. C., March 10, 1970. "Excerpts from book by N. Ye. Yaremenko and B. Ya. Svetlov, Moscow, Teoriya; Tekhnologiya Promyshlennykh; Vzryvchatykh Veshchesty. (Theory & Technology of Industrial and Explosive Substances); Russian, 1957, pp. 120-211."

11. AD-882-716 Rosenblatt, David H., et. al. Water pollution problems arising from TNT manufacture, a survey. Edgewood Arsenal Special Publication EASP 100-94. March 1971. Report discusses preliminary literature search and evaluation of environmental pollution produced by TNT manufacture, past, present, and proposed, to be "followed by detailed proposal for specific studies...."

12. AD-715-406 Summary report of work performed under Contract DAAA-21-67-C-0217, for Picatinny Arsenal by Ammann & Whitney, Consulting Engineers, New York, July 1970. "Data developed under Contract DAAA-21-67-C-0217 can be classified under 4 major topics, namely: (1) preparation of test plans, (2) summary of test results, (3) evaluation of new and/or existing explosive-manufacturing or storage facilities, and (4) design and/or analysis of protective structures." Report is strictly a summary of contract work providing report title and authors with short summary of report contents.

13. PB-161270 Fedoroff, Basil T., et. al. Dictionary of explosives, ammunition and weapons (German Section). Picatinny Arsenal Technical Report No. 2510, Dover, New Jersey, 1958. (NTIS)

14. AD-693-600 Andreyev, K. K. Thermal decomposition and combustion of explosives. Foreign Technology Division, Translated under Contract F33657-68-D-1287 P001, July 14, 1969. Source: Edited English translation of Russian text: Termicheskoye Pallozheniye i Goreniye Vzrychatykh Veschesty. (Thermal Decomposition and Combustion of Explosives.) 2d ed., revised and supplement, 1966, pp. 12-100, 260-93, 345-46.

15. AD-436-880 Toxic hazards associated with pyrotechnic items. Bureau of Naval Weapons, Navy Dept., Washington, D. C. November 1, 1963. (CFSTI) "Publication presents compilation of toxicity characteristics (in tabular form) of all pyrotechnic compositions in Fleet use, under development by Department of Defense for Naval use... Provides degree of injury imposed when Naval personnel are exposed to toxic chemical ingredients, hazardous residues, and resultant products from burning pyrotechnic compositions."... In defining toxicity data..., "system of toxicant classification used in Dangerous Properties of Industrial Materials by N. Irving Sax has been adopted."

16. AD-832-086 Ripley, William and Lipscomb, Charles A. Preliminary investigation of reactivitiy of amorphous red phosphorus. U. S. Naval Ammunition Depot, Crane, Indiana, March 25, 1968.

17. AD-413-927 Coruscatives as additives for high-blast explosives. Howard J. Vanderpluis, U.S.A.E.R.D.L. Technical Report 1743-TR, Fort Belvoir, Va. Available from CFSTI.

18. AD-289-445 Safety Manual: Laboratory Preparation of Pyrotechnics. (RDTR No. 29) U. S. Naval Ammunition Depot, Crane, Indiana. Arlington, Va., Armed Services Technical Information Agency, July 1962.

19. AD-436-880 Toxic Hazards Associated with Pyrotechnic Items. Springfield, Va., CFSTI, November 1963.